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LOCALIZING RESPONSES TO TACTUAL STIMULI IN THE FETAL RAT IN RELATION TO THE PSYCHOLOGICAL PROBLEM OF SPACE PERCEPTION*

From the Psychological Laboratory of Brown University

EDWARD T. RANEY AND LEONARD CARMICHAEL

Various studies have been made of the development of motility in the fetal rat. This work has been summarized elsewhere by one of the authors (5, pp 63-71) The present study was undertaken in order to investigate explicitly certain aspects of the development of what may be called the localizing responses made to tactual stimuli in a series of fetal rats of known and increasing gestation age. In the discussion at the end of the paper an effort is made to show the possible bearing of the experimental results secured upon general theories of tactual localization, local sign, and space perception.

In the present experiment adult female white rats of approximately the same age and genetic stock were introduced at the proper time in the oestrous cycle into a cage containing an active male rat. The exact time of mating was recorded.

At the desired number of days after insemination the adult female was operated upon so as to make possible the observation of the fetal animals under relatively normal and constant conditions. In this operation the adult female was anesthetized by ether and then the spinal cord was completely transected between the sixth and seventh cervical vertebrae. A superficial incision in the abdomen was then made and a period of approximately two hours allowed to elapse to eliminate the after-effects of the ether. As a result of the spinal-cord operation on the adult female, all sensitivity, as judged by behavior, and all "voluntary movement," is eliminated in the animal below the shoulder region. The respiratory and circulatory mechanisms, however, remain undisturbed. A negligible amount of blood is lost in the procedure. After the period allowed for the recovery from the anesthetic has passed, the adult animal is tied in a wire-mesh frame This frame is then partially lowered into a bath of physiological salt solution maintained at a constant temperature of 37.5° ± .50° C. by heating units regulated by a thermostat. A

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deeper abdominal incision is now made under water. This opens the body cavity, and the uterus is carefully lifted out. Using great care not to disturb the blood supply, each fetus is then in turn removed from its protective membranes, as it is desired to study it. The exposed fetus is supported on a watch glass held on an adjustable lead wire so that the organism remains just below the surface of the liquid. This procedure is repeated for each of the fetuses of the litter. By means of this operation, therefore, the fetal organisms are prepared for observation with placental circulation fully maintained and under conditions of temperature and specific gravity approximately those of normal uterine life. A different litter, of course, is used for each gestation age studied.

Since the chief interest in the present investigation was the observation of the development of responses to tactual stimulation at specific points on the body surface, the regions stimulated and the conditions of stimulation were kept as nearly constant as possible. The regions stimulated were: (1) the corner of the mouth region, (2) the vibrissal region, (3) the eye region; (4) the ear region; (5) the crown region; (6) the shoulder region; (7) the upper surface of the right forepaw; (8) the lower surface of the right forepaw; (9) the side region; (10) the hip region; (11) the upper surface of the right hindpaw; (12) the tail. The location of these regions, as

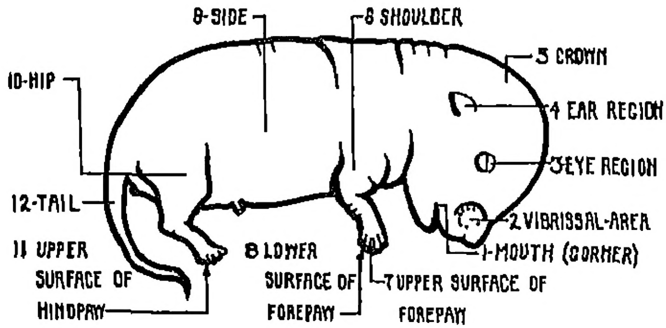

FIGURE 1

shown in a rather late fetus, is indicated in Figure 1. All of the areas indicated were on the right side of the body. In each litter the regions on the first fetus observed were stimulated in the order given above, the second in the reverse order, the third in the order

given above, the fourth in the reverse order, and so forth Each region was stimulated first by a camel's-hair brush with a tuft one centimeter in diameter and then by a single light bristle attached to the end of a stick in the manner of a Von Frey aesthesiometer At no time was a stimulus applied to the animal if the animal was not quiet. When no response was made to the first stimulation an interval of not less than five seconds was allowed before re-stimulation. The actual time between stimulations, however, varied with the amount of spontaneous activity. Every effort was made to distinguish between responses resulting directly from the experimental stimulation and mere "random activity" resulting from unknown stimulation Responses resulting from proprioceptive or other stimulation caused by the animal's own activity, even when such activity was itself a result of experimental stimulation, was recorded as a secondary response in the protocols where the observations seemed sure.

Thirty litters were used, the approximate age of the fetuses since copulation being shown in Table I. Ninety-four fetuses in all were

TABLE 1

Rat No.	Approximate age in hrs	Rat No.	Approximate age in hrs
1	384	16	433
2	384	17	446
3	396	18	446
4	398	19	450
5	406	20	455
6	408	21	456
7	408	22	456
8	420	23	468
9	422	24	470
10	423	25	480
11	424	26	481
12	424	27	491
13	426	28	493
14	430	29	498
15	433	30	506

studied in the experiment Detailed protocols and fourteen summarizing graphs representing the development of sensitivity in each region are on file in typewritten form in the John Hay Library of Brown University (24).

In this experiment, using very general terms, it may be said that the course of tactual receptivity appears to follow a cephalo-caudal, proximo-distal direction, thus confirming the work of Coghill (6, 7), Swenson (30), Angulo y González (1), Windle and Griffin (32), Coronios (8), and others. Motility of a region seemed in general to precede the possibility of bringing about a response by stimulation in that region, thus confirming the work of Preyer (23), Tracy (31), and others In general, certain head regions are the first to become receptive to tactual stimulation Receptivity, as judged by the elicitation of response, then spreads caudally and distally over the surface of the body. This is by no means a universal rule, however. For example, sensitivity appears later on the side of the head than on the pads of the digits of the forepaws. In a short time development has proceeded to such a point that almost all the surface of the body seems nearly equally receptive to areal stimulation In addition to this development, the surfaces of the more mobile parts of the body become very receptive to punctate as well as areal stimulation. This does not seem to be so constantly true of the skin covering the less mobile parts of the organism.

As tactual receptivity develops there appears to be a corresponding development in the behavior released by such stimulation This development is peculiarly difficult to describe, but it may possibly be thought of as including two types of response, which may be characterized respectively as *generalized* and *particularized* responses. It must be recognized, however, that where these responses are present at the same time in the organism no fast line of distinction between them can be made In crucial cases the judgment as to which class to assign a given response is almost a matter of indifference. The generalized response is an apparently random spreading of activity to include more and more muscle groups of the body as the gestation period progresses. The particularized response is a movement of a stimulated member alone, the movement of local muscles under the skin-point stimulated, or the movement of a limb so as to touch the spot stimulated. These particularized responses are in our observations later than the generalized responses and appear most frequently in reaction to punctate stimulation of very light pressure on the receptors of the more "sensitive" areas In certain recent experiments in another mammal Windle and his collaborators have been able to show that the first response is not

the mass movement of the neck, trunk, and limbs, but an isolated forelimb reflex (33) In the later fetuses, when the general trunk response and apparently particularized "reflexes" are present at the same time, it is pointed out that no easy distinction can be made between them. Either this genetic sequence may not hold in the rat, or, as is possibly more probable, the exceedingly transitory phenomenon was not observed by the present writers because at the time no real effort was made to observe it

In general, during the sixteenth and seventeenth days a typical movement of the fetus is one involving neck and forelimbs. Because of the concern of the present problem with localizing responses comparatively little attention will be given here to the nature of the first movements of the fetus This early period has been studied in detail by others (7, 30) As development progresses, during the seventeenth and eighteenth days, the total number of muscle groups involved in such generalized response becomes greater, and during this same period more specific movements appear, such as movements at the wrist only, resulting from the stimulation of the lower surface of the forepaw As gestation advances through the nineteenth, twentieth, and twenty-first days—that is, to the end of the normal gestation period—these generalized movements become more and more obvious During the latter part of the active prenatal period particularized movement alone may sometimes appear in response to isolated punctiform tactual stimulation Such stimulation often leads to particularized response and to what seems to be a general response of many muscle groups at the same time This is true in differing degrees and in different areas during some of the eighteenth, nineteenth, twentieth, and twenty-first days. On the less mobile parts of the body the particularized response is a localized skin twitch at the point stimulated. Such responses are noted, for example, in late fetuses to stimulation of the side of the body midway between the shoulder and the hip Following such local activity more general activity frequently follows. Such secondary activity may result from proprioceptive stimulation induced by the first response The protocols show many local responses resulting from the stimulation of the ear, side, and hip. The more specific response which appears on stimulation of the more mobile parts of the body was a definite localized movement of the member stimulated. Thus, upon stimulation of the dorsal surface of one toe of the right fore-

paw, in a number of cases the only response secured was a quick extension of the wrist, thus bringing the stimulus into more direct contact with the part stimulated. Similarly, the response following stimulation of the ventral surface of the toe was a quick flexion at the wrist, effecting the same change in relation to the stimulus. In certain instances a partial closing of the "fingers" around the stimulating object was noted. Similarly, in a number of recorded cases stimulation of the vibrissal region led the forepaw to be lifted so as to brush over the side of the face. In certain instances, the head was lowered by a change in the neck musculature after stimulation of the vibrissal region in a manner which thus made it mechanically more feasible for the point stimulated to be brushed by the homolateral forepaw. The detailed picture of the onset of motility in particular segments of the fetal rat has been summarized by one of the writers (5) from the work of Swenson (30) and Angulo y González (1). The detailed observation made in the present experiment cannot be adequately summarized without reprinting all of the protocols taken during the experimental periods. Table 2, however, gives some indication of the nature of this data.

Discussion

The question may now be raised whether the observed development of response to cutaneous stimulation in the fetal rat that has just been described has any bearing upon the psychological problems of tactual localization, local sign, and space perception. The answer which is given to this question will in a measure depend upon the point of view from which the psychology of tactual localization and related problems is approached If the psychological problems of cutaneous localization be limited to the adult form of this ability and if "position" be considered only as a conscious datum to be characterized in introspective terms, it is obvious that any reference to movements made in response to stimulation by a white rat fetus will be largely irrelevant. On the other hand, Stern (27, 28, 29) in his studies of space perception goes so far as to suggest that the problems of nativism and empiricism in space can never be solved by studying the adult's almost perfect familiarity with space, but such problems must be referred to developmental psychology (29, p. 115). If the problem of space be viewed thus genetically and if tactual or visual localization be thought of as part of the creature's

TABLE 2

SHOWING TYPICAL INITIAL RESPONSE TO AREAL STIMULATION AT 13 SUCCESSIVELY ADVANCING TEMPORAL PERIODS DURING THE FETAL LIFE OF THE RAT

Six representative points of stimulation are selected from the total areas studied. They are 1 (corner of mouth), 6 (shoulder), 9 (side), 10 (hip), 8 (forepaw, lower surface), 11 (hindpaw, upper surface)

	16½	17	17½	17¾	18	18½	18¾	19	19½	20	20½	20¾	21
I Trunk movements													
1 Lateral flexion to the right		1 6 8				9	11	10					
2 Lateral flexion to the left	1	6 10 9	8					11					
3 Dorsal extension	6 9	10	8	1		11							
4 Ventral flexion		6	8	1 9 10									
5. Bilateral flexion		6 9				1 8			10			11	
6. Associated with head movements	1 6		9 10		8	11							
7. Associated with active movements of all four legs				9						1		8	
8 Associated with active movements of the forelegs	6 9	1 10	8				11						
9 Associated with active movements of the right foreleg	6		8										
10. Associated with active movements of the hindlegs				9 10					6				
11 Associated with rump movements		6	9	10							1		
12 Associated with mouth movements					9	11		6	8				

TABLE 2 (*continued*)

	16½	17	17½	17¾	18	18½	18¾	19	19½	20	20½	20¾	21
II Head movements (independent of body)													
1 Extension		1											
2 Lateral flexion to right			1										
3 Lateral flexion to left	1												
4. Lateral flexion to left with extension					1								
5 Associated with distal extension of fore-legs		1		8									
6 Associated with distal extension of right foreleg					6								
7 Associated with caudal extension of forelegs			1	8									
8 Associated with caudal extension of right foreleg								8					
9 Associated with cephalad extension of forelegs			1						1				
10 Associated with cephalad extension of right foreleg					1								
11. Associated with cephalad extension of right foreleg to mouth region							1						
12 Associated with proximal flexion of the forelegs				1 6 11(?)									
13 Associated with proximal flexion of right hindleg		10						11					
14 Associated with active movements of all four legs											6		
15 Associated with progressive foreleg movements				1									
16 Associated with mouth opening									1				

TABLE 2 (*continued*)

		16½	17	17½	17¾	18	18½	18¾	19	19½	20	20½	20¾	21
III	Forelimb movements (independent of head and trunk movements)													
1	Distal extension of right foreleg	6					9							
2	Caudal extension						6							
3	Caudal extension of right foreleg	9			8			10				6		
4	Caudal extension of right foreleg with wrist flexion								8					
5	Caudal extension of right foreleg with lateral flexion at wrist													8
6	Progressive movements				1									
7	Cephalad extension					6								
8	Cephalad extension of right foreleg								1					
9.	Cephalad extension of right foreleg to mouth region								1 6					
10	Proximal flexion at shoulder			6										
11	Proximal flexion of right foreleg at shoulder					8 9								
12	Proximal flexion of right foreleg at shoulder and elbow					6								
13	Proximal flexion of right foreleg at shoulder and elbow and extension at wrist							8						
14	Proximal flexion of right foreleg at shoulder and elbow and extension at wrist followed by cephalad extension										6			
15	*Extension of right forepaw at wrist*							8						
16	Flexion of right forepaw at wrist								8					

TABLE 2 (*continued*)

	16½	17	17½	17¾	18	18½	18¾	19	19½	20	20½	20¾	21
IV. Hindlimb movements (independent of head and body movement)													
1 Proximal flexion at hip				10									
2 Proximal flexion at hip in right hind-leg only					10 11								
3 Proximal flexion at hip and knee in right hindleg only							11						
4 Proximal flexion at knee only in right hindleg									11				
V Rump movements (independent of head and body movements)													
1. Lateral flexion to right								10	1				11
2 Lateral flexion to left								10					
3. Ventral flexion				6									
4 Associated with foreleg movements				6 9									
5. Associated with hindleg movements			10										
6 Associated with right hindleg movements only			10										
VI Movement of muscles under skin									9	10			

general adaptation to its environment, observations of the sort reported in this paper become distinctly relevant to a complete understanding of localizing capacity and thus basically of space perception mediated by the skin In passing it may well be pointed out that, as Kulpe a number of years ago clearly indicated (16, p. 346), the motor and other components in tactual localization must always in a measure be dependent upon special anatomical and physiological aspects of the cutaneous receptors themselves. Hoagland and other students of the cutaneous nerves have recently been dealing with this essential neurological basis for cutaneous localization (11, 12, 13). Facts of the sort established in these studies are basic to the phenomena considered in this paper, but must not, of course, be confused with the phenomena which are treated here.

The genetic point of view in regard to localizing responses has been considered important by many students of perceptual phenomena. Thus, for example, Luciani (17, p. 108) specifically refers to the bearing of Preyer's work (23) on the development of fetal sensitivity in relation to his treatment of cutaneous perceptual phenomena. In a similar manner, Peterson (19), in an illuminating consideration of the relationship between orientation tendencies and local sign, speaks of the importance of the study of young organisms in building up a correct understanding of the individual's orienting responses to bodily stimuli (19, p. 233). This same writer further points out that in his opinion such studies will make available facts by means of which the interminable discussions between nativists and empiricists can be, if not settled, at least avoided Stern likewise believes that developmental studies will show the nativism-empiricism question with relation to space to have been wrongly formulated (29, p. 115). Against the possible all-sufficiency of the developmental approach to the psychological problem of cutaneous localization, however, may be urged the consideration of the large number of experimentally determined facts concerning the part played by visual and tactual imagery, as well as by experiences of kinesthetic origin, in the adult human perception of position on the skin. For a review of the history of this point of view one may consult Boring's treatment (2) of its development in the experimental and theoretical work of Berkeley, Weber, Lotze, Helmholtz, Wundt, and Henri (10). Indeed, on the basis of the work of these classical investigators and also upon the more recent work of Ponzo (22), Franz (9), and

others, Pillsbury (20), himself one of the early experimental students in this field, concludes:

> It is likely that position itself is an idea so frequently used that its nature has become very complex and the elements are no longer analysed from the mass. It is made up partly of movements or tendencies to movement and partly of ideas derived from sight or touch as the case may be, but also involving a number of other elements . . . with use the completed notion has come to replace the different elements so entirely that they are lost in it, and cannot now be analysed from it. (21, p. 178)

Thus it may be asserted that a description of localizing behavior in a fetal organism may present data that will be relevant to the psychology of tactual localization, local sign, and space perception, mediated through cutaneous stimulation. But it must also be remembered, of course, that evidence secured from such studies will not necessarily suffice to answer all of the true problems of space perception, especially when such problems are phrased in terms of the description of adult conscious experience. Thus, even if it can be shown that localizing movements are always genetically prior to the adult experience of position, it does not mean that genetically other significant factors have not entered into the development of the adult capacity, at least in the human individual. Peterson has presented well-considered arguments and experimental findings which seem to show that the ability to localize is learned like any habit (19). As Klein (15) has shown, however, even in simple pointing, factors having genetic origin in eye and head movement, visually perceived and imagined movement, the effect of labyrinthine stimulation, kinesthetic and tactual stimulation, may all play a part.

The genetic development of space perception is considered by Renshaw (25, 26), on the basis of experiments on adults and children, to be complexly determined. He has shown that in his experiments children localize more accurately than adults, when both are blindfolded, but that this is not the case when vision is not impeded. On the basis of this work, as well as upon work on blind subjects, Renshaw concludes that possibly the adult perception of position undergoes a qualitative as well as a quantitative change in development. This change may, it seems, be correlated with the central-nervous-system change which makes distance receptors more effective in determining adaptive responses as development progresses. It may indeed be not unrelated to the general "encephalization" of the

adaptive functions of the organism in relation to external stimuli (18). It seems possible that this change of function may be considered in terms of the development of effective habits, mediated by distance-receptor stimulation, which occur as a result of the organism's progressively more successful adjustment to its environment Thus it may be that behavior released by tactual and kinesthetic receptor stimulation in early life may come to some extent under visual domination in later life.

Thus, in asserting that a study of the change in precision of localizing response in a fetal mammal such as that reported in this paper is significant for the understanding of cutaneous localization, local sign, and space perception, no claim is made that an understanding of this phenomenon is all that is needed for a complete descriptive psychological account of tactual perception or, indeed, of a complete genetic story of such behavior. It does seem, however, that the facts presented above in this paper may supply some data concerning the development of capacities which are significant in the growth of such perception at a more primitive genetic level than has hitherto been described.

It must be understood that no claim is made that because the fetus makes localizing responses that the identical central nervous system factors are involved in such responses as in adult cutaneous localization. Kulpe's objection to the "localizing movement" theory of tactual localization based upon the ability of spinal animals to localize (16, p 345) is not, it seems to the present writers, an objection to considering this sort of localizing as a significant genetic factor, but merely to considering it as the only factor important in normal adult cutaneous localization. It may even be that a distinction of behavioral, physiological, and experimental significance between lower "reflex localizing" and localizing responses determined by activities of the higher neural centers will be established The detailed study of the behavioral development of the plantar reflex in relation to its central nervous system connections gives analogous evidence for such a genetic change (5, p 109). A change of this sort, however, does not affect the validity of a descriptive genetic developmental picture of the sort given in this paper In the same way, cortical projection theories of the sort recently reviewed by Boring (4), while of the greatest significance for a complete understanding of cutaneous localization, are not relevant to the special problems of this paper.

With this point of departure in mind we may now review the findings of the present study of fetal responses which seem relevant to an understanding of the development of localizing behavior and even to cutaneous space perception itself. It may be noted that the basis of localizing behavior and the two-point limen are not physiologically as distinct as was at one time supposed, as has recently been suggested by Boring (3).

1. No evidence was found that the first responses to cutaneous or other exteroceptive stimuli appear in an area until muscles associated with that area have been active. Nothing, that is, in the present study has been found to contradict Preyer's law of development, namely, that *"die Sensibilität tritt regelmässig später auf, als die Motilität"* (23). In other words, there is evidence to show that in the time sequence of genetic development the capacity of the cutaneous receptors to initiate behavior of any sort in any part of the organism has not been shown to arise until the muscle mechanism associated with the particular area in question has brought about the movement of that surface. In this connection the work of Tracy (31) on the development of motility and behavior reactions in the toadfish seems relevant. This investigator concludes that the first responses of that organism result from internal stimuli which arise as a result of the organism's own metabolic processes. When this first behavior appears, the organism is not exteroceptively sensitive at all. Soon after the onset of this internally conditioned behavior, however, exteroceptive sensitivity appears. Such sensitivity is seen first in the mouth region and then spreads rapidly in a caudal direction. On the basis of these observations Tracy suggests that the organism at the beginning and more or less continuously throughout its whole existence is driven through its environment as a result of stimuli arising periodically in its own body as a result of its own metabolic processes. Exteroceptive stimulation, when it develops, may, from this point of view, be considered as interrupting or redirecting a pattern of behavior initiated by rhythmically active internal stimuli. Therefore it may well be that external energies first initiate processes which gain their "meaning," in a behavioral sense, in that they interrupt or facilitate behavior which is itself occurring, at first, quite without reference to the external environment. The first actual responses may sometimes be determined by internal stimulation and by the make-up of the body, especially the neuromuscular

mechanism, but, in regard to the external environment, they remain in the fullest sense of the term *random*. From one point of view it may therefore be that the whole story of the development of adaptive, discriminative behavior, and thus of perception itself, may be considered as beginning in a condition of absolute non-specificity and gradually becoming, as described in this paper, more and more specific in relation to external stimulation as differential growth continues. That the development of cutaneous sensitivity later than motor response is possibly not an absolute rule has recently been shown by Windle and his collaborators

2. The experiment reported above shows that as the cutaneous receptors become functional the first responses which are elicited are, in the animals studied in this investigation, more diffuse and generalized and less differential in relation to the part stimulated than they are as development progresses. Thus, in the earliest rat fetuses studied, no matter where stimulated, neck or trunk bending resulted. As development progressed, specificity of response increased. These specific responses, as described above, were of the following sorts: (1) *abient* or *adient* movements [in Holt's sense, (14, p. 41)] of a segment of the body that is stimulated in regard to the point stimulated; (2) movement of a limb in such a manner as to touch or nearly touch the point stimulated, (3) movement of the musculature underlying the point on the skin stimulated.

Holt has considered the development of localizing behavior to result from learning (14, pp. 73-83). The observations made in this study neither confirm nor refute this view. At the strictly observational level of this paper, development might be considered to result from either maturation or learning, or from some combination of the factors ordinarily considered under these two headings. In most general terms, however, the paper does suggest the tenability of a view that the precise cutaneous localizing capacity of the adult, mediated as it seems to be at least by tactual, kinesthetic, and visual components, may be conceived of as genetically originating in movements which are at first absolutely, or at least very largely, unrelated to external stimulation, and that after this initiation during fetal life the capacity for more accurate localization gradually develops

As a theoretical interpretation, therefore, it may be suggested, on the basis of the present observation and on the basis of investigations such as those of Renshaw referred to above, that it is possible to

consider the ability to perceive space in descriptive genetic terms without reference to the formalized concepts of nativism and empiricism. This genetic sequence may even begin in responses which are at first quite unrelated to exteroceptive stimulation. Next, it may be, the gradual development of responses which involve both exteroceptive and proprioceptive stimuli occur, making localization on the body surface possible. Finally, in man, as a part of what has been called the general encephalization of function, visual and possibly other head exteroceptors come to be involved in adult space perception, mediated through cutaneous stimulation and special cutaneous processes of the sort described by Hoagland (13). If this suggested course of development be considered as an approximately satisfactory account of the growth of cutaneous space perception, then the development of localized response in fetal rats described in this paper may be considered as throwing some new light on what may be called the "fetal segment" of this course of development. This segment may not be as important as other genetic segments in an understanding of space perception, but, save for Luciani's reference to Preyer's work noted above, it seems to have been, previous to the present paper, almost completely neglected

Summary

Selected cutaneous areas of ninety fetuses from thirty litters of different and increasing gestation age were systematically stimulated in order to study any changes in so-called "localizing responses" which might appear. As the normal birth-time approached greater specificity of response in relation to stimulation was found in (1) the particularized movement of the member stimulated; (2) the movement of local muscles under the point stimulated; (3) the movement of a limb so as to touch the point stimulated. These results are interpreted as contributing to the knowledge of what may be called the "fetal segment" of responses which must be considered in a complete genetic description of space perception.

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LA LOCALISATION DES RÉPONSES AUX STIMULI TACTILES CHEZ LE RAT FOETAL À L'ÉGARD DU PROBLÈME PSYCHOLOGIQUE DE LA PERCEPTION DE L'ESPACE

(Résumé)

On a stimulé systématiquement des aires cutanées choisies de 90 foetus de 30 portées d'un âge de gestation différent et augmentant dans le but d'étudier les changements qui pourraient se montrer dans les soi-disant "réponses localisantes." Comme le temps normal de naissance s'est approché, on a trouvé une plus grande spécificité de réponse à l'égard de la stimulation dans (1) le mouvement particularisé du membre stimulé, (2) le mouvement des muscles locaux sous le point stimulé; (3) le mouvement d'un membre pour toucher le point stimulé. On interprète ces résultats comme une contribution à la connaissance de ce qu'on peut appeler le "segment foetal" des réponses lequel on doit considérer dans une description génétique complète de la description de l'espace.

RANEY ET CARMICHAEL

DIE LOKALISIERUNGSREAKTIONEN AUF TASTREIZE BEI DER FÖTUSRATTE IN BEZIEHUNG ZU DEM PSYCHOLOGISCHEN PROBLEM DER RAUMWAHRNEHMUNG

(Referat)

Ausgewählte Hautflächen von 90 Fötus aus dreissig Würfen von verschiedener und zunehmender Trächtigkeit wurden planmässig gereizt, um Aenderungen in den sogenannten "Lokalisierungsreaktionen" festzustellen, die erscheinen möchten. Als die normale Geburtszeit annahte, wurde grössere Spezifizität der Reaktionen in Beziehung zu der Reizung festgestellt in (1) der partikularisierten Bewegung des gereizten Gliedes; (2) der Bewegung der örtlichen Muskeln unter dem gereizten Punkt, (3) der Bewegung des Gliedes zur Berührung mit dem gereizten Punkt. Diese Ergebnisse werden als Beitrag zur Kenntnis dessen gedeutet, was das "Fötussegment" der Reaktionen genannt werden dürfte, das bei einer vollkommenen genetischen Beschreibung der Raumwahrnehmung in Betracht gezogen werden muss.

RANEY UND CARMICHAEL

GENERALIZATION AND SPECIFICITY OF THE PLANTAR RESPONSE IN NEWBORN INFANTS. THE REFLEXOGENOUS ZONE: II SEGMENTAL PATTERNING OF RESPONSES*[1]

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INTRODUCTION

In the first paper (5) of this series upon the plantar response in newborn infants, an investigation dealing with certain aspects of the reflexogenous zone was reported. The recording of homolateral segmental responses (toes, foot, leg, and thigh) of the inferior limb, in 55 newborn infants ranging from 1-21 days in age, to stimulation of twelve cutaneous areas of that member produced two criteria of differentiation: (1) differential sensitivity, and (2) the extent and character of segmental representation in the responses. The extent of the segmental participation afforded evidence on the relative degree of specificity, in the sense of limitation, of the responses. Zones of secondary differentiation within the general reflexogenous zone of the plantar response were discovered by analysis of responses into their segmental elements.

Quantitative differences in segmental representation do not, however, exhaust the means of comparison of one area with another so far as resemblances or differences in receptor-effector hook-up or organization are concerned. It is possible to effect further comparisons by finding the *number* of different segmental *patterns* or *combinations* (different response patterns) per area as well as the relative frequency of such responses. According to these indices, that cutaneous area will be most generalized which is bound up with the greatest number of different types of response, and that one in which the frequencies of response are most widely dispersed over the available response patterns. That area will be most specific which is

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[1]In addition to the acknowledgments tendered the National Research Council, and others, in the first paper of this series, the writer wishes to express his appreciation for valuable advice by Dr. H. E. Burtt concerning the interpretation of the observed variability of response in relation to the mathematical possibilities.

the stimulogenous zone for the fewest types of response with the most concentrated frequencies Further, that area will be "specific" according to the extent to which it has *unique* possession of the response patterns. This use of the terms "specific" and "generalized" does not refer directly to the relative degree of *segmental* limitation of the responses, but rather to the relative invariability of their occurrence (4). It is evident that the latter criterion of specificity ultimately resolves itself into the effective limitation in receptor-effector *connections*.

An examination of the variability in the patterning of responses should clear doubts as to the possibility of consistency or regularity in neonate behavior, and should permit us to evaluate the tradition that the newborn infant is endowed with very specific reflexes. If there were *no* organization favoring the appearance of a fairly limited number of response *patterns*, one would expect about as many kinds of response as the case-limits of the sample or the mathematical possibilities of segmental patterning would permit. It is highly doubtful that the anatomical possibilities are the same as the mathematical possibilities, but obviously the limitation extends still further and is physiological in nature.

The mathematical possibilities of segmental patterning depend upon the number of segments under observation and upon the number of ways in which these segments may be represented in a response. In the present study, movement in 8 segments was recorded: the five toes, the foot, the leg, and the thigh. Aside from the movements in the *signe d'éventail* of the toes, two types of movement, flexion and extension, were possible in each segment. Each of the 8 segments therefore could do one of three things: it could flex, extend, or fail to participate in the response Under these conditions 6560 different segmental combinations are possible! A comparison of this value with the response patterns and response frequencies obtained in the present investigation will go far towards the evaluation of variability in behavior

Lastly, this inventory will indicate whether the term "plantar response," or any of the nomenclature for responses evoked through excitation of cutaneous areas of the leg, is sufficiently precise to have value in the systematic and descriptive classification of behavior

Results

In this investigation twelve cutaneous areas of the right leg and

the plantar median line of the left leg were stimulated Location of the areas is given in Table 2 The details of the experimental technique have been presented in an earlier paper.

If one of the objects of this paper is to discover the extent of the stimulogenous zone for certain responses, it is important to note what responses are brought about by stimulation of all thirteen[2] areas, of twelve areas, eleven areas, and so on Obviously, those responses

TABLE 1
DISTRIBUTION OF RESPONSES AND OF DIFFERENT RESPONSE PATTERNS ACCORDING TO THE NUMBER OF CUTANEOUS AREAS INVOLVED

No. areas	No. R P's	% R P.	f	% f	f/A(R P)
13	4	2.16	451	28 52	8 67
12	2	1.08	136	8 60	5 66
11	4	2 16	181	11 44	4 11
10	2	1.08	57	3 60	2 85
9	6	3 24	146	9 23	2.70
8	4	2 16	79	4 99	2 46
7	5	2 70	105	6.64	3 00
6	8	4.32	87	5.50	1 81
5	10	5 40	77	4 87	1 54
4	10	5 40	53	3 35	1 32
3	15	8.10	62	3 92	1 37
2	22	11 89	49	3 09	1.11
1	93	50.27	98	6 19	1.05
Totals	185		1581		

Legend
No areas, number of cutaneous areas involved
No R P.'s number of response patterns
f, number of responses
% f, % of responses to total responses
% R P, % of R P's to total R P's
f/A(R P), number of responses per pattern per area

which are released by excitation of the largest number of cutaneous areas will be most generalized with respect to their stimulogenous

[2]In this analysis we have included the homolateral responses to stimulation of the left median plantar This gives the symmetrical distribution of the response patterns but does not, *strictly speaking, provide the same information* as do the responses to stimulation of areas of the same leg. To make this item strictly comparable so that stimulation of the left leg would furnish evidence regarding the extent of the reflexogenous zone, the contralateral responses should have been recorded This could not be accomplished with sufficient accuracy in this research. The left plantar homolateral leg responses are included in other portions of our analysis and will not appreciably distort any aspects of the problem.

zone, no matter how localized the responses may be Likewise, on the stimulogenous side, those responses are most specific which are unique to a given area, regardless of the localization of the responses However, a great number of unique responses with low frequency of occurrence is evidence of wide-spread receptor-effector connections and hence of relative generalization. These relations are presented in Table 1, which shows that:

1. The different cutaneous areas of the leg are stimulogenous zones, or are different points in a single zone the stimulation of which will release the same response patterns Thus in the twelve areas studied in the *Rt leg* and the one in the *L. leg* there appear 4 response *patterns* (2 16%) and these account for 28 52% of the total responses Similarly twelve areas have 2 response patterns in common, eleven areas 4, and ten areas 2 *response patterns.*

2 Out of 185 response patterns, 93 are unique in that individually they do not occur to stimulation of more than one area

3. These 93 unique responses constitute approximately 50% of the response patterns but represent only approximately 6% of the total responses.

4 The response patterns (12 in all) produced by stimulation of 13, 12, 11 and 10 areas comprise about 6% of the response patterns, but include about 52% of all responses.

5. The response patterns appearing to stimulation of 4, 3, 2, and 1 areas, 140 in all, make up 76% of the response patterns but include only about 16% of the total responses.

6. Usually, the more generalized the response—from the standpoint of the stimulogenous zone—the greater is its frequency of occurrence per area of stimulation Thus there are 8 67 responses per pattern per area when the response appears for all 13 areas of stimulation, and only 1 05 responses per pattern per area when the response pattern is unique to a given area

The range of the R-E (receptor-effector) connections of a cutaneous area may be gauged by the number of response patterns appearing upon stimulation of the given area The greater the number and the more dispersed the distribution of responses the greater is the generalization of the R-E connections The higher the degree of concentration of the frequencies of response the more evidence there is for the operation of limiting factors

An inventory of response patterns and their relation to the total responses for each cutaneous area is given in Table 2 This table shows that:

1 In general, those areas which are most sensitive (arranged in descending order in the table) also have more variable R-E connections, since in their case excitation arouses more *response patterns* Thus *Rt. plant. med.* has 61 different response patterns, *hal plant. s.* 48, while *T2 dorsum* has only 28.

2. The relationship is not directly proportional, for the ratio *f/R P.* indicates that the plantar areas produce slightly more responses per pattern than do the other areas The range is from

TABLE 2

THE FREQUENCY OF RESPONSE, NUMBER OF RESPONSE PATTERNS, AND THEIR INTER-RELATION FOR EACH CUTANEOUS AREA OF STIMULATION

Areas of stimulation	f	No R P.	f/R P	U.R P	% U R P	R P 75%	R P 50%
Rt plant. med	187	61	3.06	11	18.03	19	8
L. " "	189	66	2.86	16	24.24	24	8
Rt. " mes b.	181	61	2.96	14	22.95	19	7
" " lat. "	181	58	3.12	13	22.41	17	5
" hal. plant s.	136	48	2.83	10	20.83	14	3
" pedes dorsum	112	43	2.60	6	13.95	17	6
" T2 plant s	94	35	2.68	3	8.57	16	5
" tend Ach. ins	89	38	2.34	5	13.15	16	6
" T5 dorsum	86	33	2.60	2	6.06	13	6
" leg mes s	85	37	2.29	7	18.91	16	6
" hal dorsum	84	37	2.27	1	2.70	16	6
" T5 plant s	80	34	2.35	3	8.82	16	7
" T2 dorsum	77	28	2.75	2	7.14	11	5

Legend:

Rt. plant med, right plantar median line; L plant. med, left plantar median line, plant mes b., plantar mesial border, plant lat b, plantar lateral border; hal plant s, hallux plantar surface, pedes dorsum, top of foot, T2 plant s., T2 plantar surface; tend. Ach ins, insertion of tendon of Achilles, T5 dorsum, top of T5; leg mes s., mesial surface of leg at knee; hal dorsum, top of hallux; T5 plant s., T5 plantar surface, T2 dorsum, top of T2

f, number of responses elicited by stimulation of the areas

No. R P., number of response patterns

f/R P, number of responses per response pattern

U R P., response patterns unique to the area

% U.R P., % of U R.P to total R.P

R.P 75%, number of response patterns accounting for approximately 75% of the total responses for the area

R P 50%, number of response patterns accounting for approximately 50% of the total responses for the area

3.06 responses per pattern for the *Rt. plant. med.* to 2.29 for the *leg mes. s.*

3. In regard to the percent of unique response patterns per area (*U.R.P./R.P. x 100*) the same trend is shown, although with greater irregularity, as has been noted in 1.

4. The number of response patterns responsible for approximately 50% of the total responses per area is about the same in order, although the range is from 8 for the *Rt. plant. med.* to 3 for *hal plant. s.*

5. To obtain approximately 75% of the total responses the number of response patterns (compared to those required to secure approximately 50% of the responses) must be more than doubled.

The actual patterning of responses in terms of the segments involved and the character or type of the movements is presented in Table 3. A third feature of patterning, namely, the sequential or temporal character, could not be recorded in this research.

The 27 response patterns accounting for about three-fourths of the total responses of the thirteen areas are analyzed and tabulated according to the range of their distribution over these areas. The table shows that:

1. Only 6 of the 27 response patterns involve flexion of any of the toes.

2. 17 of the 27 response patterns involve extension of some of the toes.

3. There are no extension movements of the foot, leg, and thigh segments in these patterns of response.

4. The hallux is the only toe to appear as the sole constituent of a pattern.

5. Out of 24 responses involving the toes all participate in 9, the hallux in 17, T2 in 19, T3 in 18, T4 in 16, and T5 in 12 of the patterns.

6. "Fanning" occurs in conjunction with extension of the toes.

7. The toe components are absent in 4 of the patterns.

8. In the 27 response patterns listed, the only patterns which are limited to one segment are Ft-fl, Hal-x, Hal-fl, and Leg-fl in the order named, with respect to the frequency of occurrence. Of these, Ft-fl leads with 162 responses occurring in 13 areas, Hal-x follows with 105 responses. Hal-fl and Leg-fl occur only in 7 areas, the former with a frequency of 35 and the latter with 18.

The distribution of responses in the 27 response patterns for the different cutaneous areas is indicated in Table 4. This is expressed in terms of the per cent of responses per pattern of the total responses appertaining to each area Thus we find that·

1 Of the total responses for the *Rt. plant med.* area T-x, Ft-fl accounts for 10%; T-x-v, Ft-fl for 9%; Ft-fl for 6% and Hal-x for 5%. A similar distribution is found upon stimulation of the *L plant med* · T-x, Ft-fl 12%, T-x-v, Ft-fl 9%; Ft-fl 7%; and Hal-x 5%. In the *Rt. plant mes. b*, Ft-fl shifts to first place with 16% and Hal-x drops to 3%. In the *Rt. plant lat. b.*, T-x, Ft-fl accounts for 17% and Hal-x for 2%.

TABLE 4
RELATIVE DISTRIBUTION OF RESPONSE PATTERNS ACCORDING TO THE AREA OF STIMULATION

Pattern responses	A	B	C	D	E	F	G	H	I	J	K	L	M
Ft-fl	6	7	16	11	8	10	5	12	13	5	10	11	23
T-x, Ft-fl	10	12	7	17	3	9	3	12	7	6	8	9	3
Hal-x	5	5	3	2	16	1	26	2	6	2	13	4	8
T-fl	3	2	3	1	5	4	1	3	5	1	4	1	3
Hal-x, Ft-fl	5	7	7	5	16	2	9	0	1	4	8	9	5
T-x	4	2	1	1	1	2	1	4	2	0	1	6	9
T-x-v, Ft-fl	9	9	7	10	1	11	3	7	9	0	6	5	0
Hal, 2, 3, 4-x, Ft fl	4	3	1	3	1	3	2	3	3	1	0	1	0
Ft-fl, L-fl	1	2	3	2	1	1	1	2	0	4	1	3	0
T-x, Ft, L, Th-fl	2	2	3	1	0	1	1	1	1	1	1	1	0
T-x, Ft, L-fl	4	2	4	4	1	3	2	1	1	4	0	0	0
T2, 3, 4, 5-fl	2	1	1	0	3	1	0	0	1	2	4	3	1
T-fl, Ft-fl	6	3	4	3	0	2	1	0	0	0	1	3	4
T2, 3, 4, 5-x, Ft-fl	0	1	3	5	0	11	1	3	2	0	0	1	5
T-x-v, Ft, L, Th-fl	3	2	2	1	0	1	2	0	0	2	0	3	1
Hal, 2, 3, 4-x	1	0	0	0	1	2	3	1	7	0	2	3	5
Ft, L, Th-fl	2	0	4	1	1	1	0	3	2	2	0	0	0
T2, 3, 4, 5-x	1	0	0	1	0	4	1	1	9	0	0	4	3
T2, 3, 4-x	1	0	0	0	1	1	0	3	6	0	2	5	3
T-x-v	1	2	1	2	0	0	1	3	2	0	2	0	0
Hal-fl	0	1	0	0	15	4	2	4	0	1	2	0	0
T2, 3, 4-x, Ft-fl	1	0	1	4	0	4	0	3	0	0	2	4	0
L-fl	0	1	1	0	0	4	0	1	1	10	1	0	0
T2, 3, 4-fl	0	1	0	0	1	1	6	0	0	0	1	3	1
Hal-fl, Ft-fl	0	1	3	2	1	1	0	0	0	0#	0	1	1

I, Th-fl 18% and L-x 8%

Legend

The per cents of the frequency of each response pattern to the total responses per area are stated to the nearest whole number

Pattern response, same as in Table 3

A, B. C, etc., Rt. plant med, L plant med, Rt plant mes b etc as in Table 2

2. Stimulation of the *hal. plant. s*, as compared with plantar areas, releases a higher percent of responses involving that member either alone or in combination. For example we find Hal-x with 16%, Hal-x, Ft-fl 16%, Hal-fl 15%. Almost 50% of the responses are centered in these three patterns.

3 Responses to stimulation of *pedes dorsum* are characterized by a drop in those patterns that involve the hallux. The figures are: Hal-x 1%; Hal-x, Ft-fl 2%, while T2, 3, 4, 5-x, Ft-fl possesses 11% of the responses

4. The greatest concentration of responses in a single segment is encountered in the case of *T2 plant s* stimulation; but that concentration is not in T2, but rather in Hal-x, which has 20% of the total responses. Hal-x, Ft-fl with 9% also ranks high.

5. Stimulation of *tend Ach ms* gives Ft-fl 12% and T-x, Ft-fl a like amount. Hal-x is only 2%.

6. Stimulation of *T5 dorsum* releases Ft-fl 13%; T-x-v, Ft-fl and T2, 3, 4, 5-x each 9%; and Hal-x 6%.

7. When the *leg mes s.* is excited the response patterns involving the toes are decreased in relative frequency, while those involving the thigh and leg are increased. Of the 27 response patterns, L-fl accounts for 10% of the responses. In the case of this area, however, the highest frequency of response involves a pattern outside the 27 patterns listed L, Th-fl takes 18% of the responses and L-x 8%.

8. Stimulation of the *hal. dorsum* releases responses involving that segment to a lesser degree than does stimulation of *hal plant s.* The values are : Hal-x 13%; Hal-x, Ft-fl 8%.

9. Stimulation of *T2 dorsum* arouses responses concentrated primarily in Ft-fl with 23%, although Hal-x has 8% and T-x 9%.

Summary and Discussion

1. *Limitations upon the Segmental Patterning of Responses*

The mathematical limits. The mathematical limits of patterning are determined by the number of combinations of segmental movements which can be made. The number of such combinations depends upon the number of segments available, and upon the number of types of movement that is possible for these segments.

In this study, the segments singled out for observation were the thigh, the leg, the foot and the five toes. In these segments two types of movement, flexion and extension, with a third (fanning) occurring in the toes, were recorded

Taking into consideration only flexion, extension or non-participation of a segment in a response, 6560 combinations are possible among the 8 segments! For instance, any one of the three possibilities with the thigh might combine with any of the three for the leg, i.e., 9 possible combinations. Any of these 9 might combine with any of the three for the foot, etc. The total possibilities obviously would be 3^8 equalling 6561. Deducting the one combination of non-participation of all segments we have 6560 possible combinations of segmental movements. If the additional movement of the toes in the *signe d'éventail* were included in our calculations the number of combinations would be much increased. Similarly, if the study included the sequential aspects of the segmental patterning of responses the number of permutations would be truly astounding—and this with all other segments of the organism excluded from the reckoning!

It should be realized that not all of these mathematically possible combinations of segmental movements are mechanically or anatomically possible Nevertheless the latter aspect certainly approaches that limit, so any marked disparity from this number must be the result of limiting factors of a physiological nature. Those who hold to an essentially chaotic complex of behavior in the newborn infant must support their view by demonstrating a variability in patterning which approaches the anatomical possibilities. Those who insist that the infant's behavior can be inventoried in terms of very limited and rigid reflex patterns must give evidence of such limitation. A comparison of the actual limits of patterning with the theoretical limits will go far towards defining the nature of the neonate organism

The actual limits 2600 stimulations of 13 different cutaneous areas of the inferior extremity elicited 1581 responses in the homolateral limb, and these were distributed among 185 response patterns. The latter are obviously less than 3% of the total possible segmental combinations The question might arise as to the adequacy of our sample of 1581 responses A strictly statistical interpretation is rather intricate and perhaps not necessary to establish our point. Compared to the great majority of psychological studies 1500 constitutes a rather adequate sample. It seems probable that additional cases would not appreciably increase the number of patterns Certainly it is doubtful that the number of patterns would increase directly as the size of the sample within the range above

1581 Even if it did and we ran the sample to 6560 we would have only 770 patterns, which is less than 12% of the mathematical possibilities It is almost inconceivable that the proportion would go higher than this. In our opinion it would remain much less—somewhere near the 3% found in the present sample. On either assumption it would seem that we had made our point that the actual limits of patterning fall far short of the mathematically theoretical limits.

Examination of the distribution of the total responses (1581) reveals that approximately 50% (93) of the response patterns are unique to certain areas. Further, these responses are usually not repeated in the sample, as is demonstrated by the fact that they only account for about 6% of the total responses On the other hand, about 15% (27) of the response patterns include almost 75% of all responses; 6% (12) of the patterns comprise 50% of the total responses to stimulation of 13 different areas; and 2% (4) of the entire number of response patterns have about 29% of the entire body of responses It should also be noted that at least 25 of our patterns include either fanning of the toes, or a segmental flexion followed by extension or the reverse sequence. These contingencies were not included in the computation of the mathematical possibilities.

However, this evidence of a limitation in response patterns is not *equivalent to maintaining that there is a high degree of specificity* in many aspects of the behavior of the neonate Quite an extensive stimulogenous zone for these responses is indicated by the fact that (1) 4 patterns (2%), accounting for 29% of the responses, are found upon stimulation of all thirteen areas (including one so far away from the *plant. med. line* as the *leg mes. s.*); and that (2) 12 patterns (6%), extending to at least 10 of the areas, take in 50% of the total responses, while (3) 27 patterns (15%) extend to at least 7 areas and include 75% of all responses.

2. *The Reflexogenous Zone and the Segmental Patterning of Responses*

The relative specificity of stimulogenous zones in terms of response patterns. In my preceding paper upon the plantar response, "specificity" or "generalization" was expressed in terms of the segmental spread of the response, i.e., the average number of segmental movements per response. Attention was directed primarily to the

relative *localization* of the response. The greatest degree of segmental participation was obtained when the *plantar med. line* (6.03) was stimulated, and the least (2.77) when the *hallux plant. s.* was excited. Additional segmental analysis of responses demonstrated that when certain areas were stimulated the response tended to be restricted to certain segments. Thus, excitation of T2 and *hal plant. s.* was followed primarily by responses located in the hallux. On the other hand, excitation of the *leg mes. s.* tended to concentrate more of the responses in the leg and thigh. Similarly a survey of the character of segmental movements indicated that the type of movement, whether flexion or extension, was dependent to a certain extent upon the area of stimulation.

This resolution of responses into their segmental elements masks an important criterion for the differentiation of secondary zones or areas, and for a further index of the specificity of a given area, namely, the patterns of response. If that area manifests greatest generalization which releases the greatest diversity of responses, and if the greatest specificity is exhibited by the area which releases fewest types of responses, it is apparent (Table 2) that the plantar areas —the *Rt. plant. med.* for example with 61 response patterns—are most generalized. Hence all of our criteria indicate the greatest variability of response when these areas are excited. The area with least response patterns (28) is *T2 dorsum*. From this angle the latter area is more specific than *hal. plant. s.* which, indeed, rates next to the plantar areas in the number of patterns (48). The number of *unique* response patterns per area likewise discloses the plantar areas and the plantar surface of the hallux as having the greatest variability of patterning.

But the number of response patterns must not be considered independently of their frequency of occurrence. Of two areas having the same number of patterns, that area which has the greater concentration in its responses will be more specific. The gross value obtained by the ratio of R's to R. P's is not the best index of the significant degree of concentration of responses. If we take for each area the number of response patterns which will include 50% of the total responses to stimulation of that area, it becomes evident that the plantar area is most generalized, for it requires 8 patterns for the *Rt. plant. med.* to about 3 for *hal. plant. s.*, the latter thus proving to be the most specific area.

Shifts in the frequency of occurrence of certain response patterns according to the area of stimulation. If a certain response pattern occurs with approximately the same relative frequency upon the stimulation of different cutaneous areas, it may safely be maintained that these areas are points within the reflexogenous zone of that response. The more numerous and widespread the areas in which this is true, the greater is the extent of the reflexogenous zone for the response (Table 4).

A decided shift in the relative frequency of occurrence of a given pattern or patterns is in itself an indication of some secondary differentiation of the area, or, if the shift swings radically beyond the other response patterns, it may be evidence that we have entered another reflexogenous zone.

3 *The Segmental Patterns of Response* Is there a plantar response? An examination of the results in Table 2 reveals that 61 patterns of response were produced by stimulation of the *Rt. plant med.* It requires 19 of these to include 75% of the responses, and 8 to include 50%. It is not evident that Bersot (1) is correct in maintaining that there is no one plantar response, and that it is a mistake to isolate only one or two elements and to report them as *the* plantar response? Clearly the identity of the topographical area that is stimulated is not a sufficient basis for the classification of responses. If we single out one response pattern and identify it by a name e.g., if we term *hallux extension* the "Babinski reflex," we determine our classification by the segmental character of the response. Historically, the term "Babinski reflex," in the narrowest sense, has meant extension of the hallux, and usually of the other toes also, upon stimulation of the *plant med line.*

In practice, when such a response or responses are found in consequence of stimulation of other areas, the same response pattern has been given a variety of names If hallux extension, followed by extension of the other toes, occurs as a result of stimulation of the tendon of Achilles by pinching, the response is termed "Schaffer's reflex", if in consequence of stimulation of the muscle of the calf of the leg or of the flexor muscle of the toes by pressure it is called "Gordon's paradoxical reflex"; if by friction of the anterior external fascia of the leg it is known as "Oppenheim's reflex"

Similarly, the so-called reflex of triple retraction of the foot, leg, and thigh upon stimulation of the plantar median line occurs, not

only in pure form but compounded with toe movements, upon stimulation of other regions of the inferior extremity "Rosolimo's reflex," a flexion of the hallux as well as the other toes to stimulation of the ball or fleshy part of a toe by a blow—the foot being in pronounced extension—likewise takes place when other areas are stimulated by a stroking contact Percussion of the 4th metatarsal on the top of the foot releases a flexion of all toes except the hallux This response, known as "Mendel-Bechterew's reflex," may be released also by other means and through other areas

Bersot (1) and Boisarelli and Pochino (2) hold that nothing is gained by considering these as separate reflexes in a systematic sense As Bersot insists, we must never lose sight of the fact that it is really an organism which is responding, and the final picture which is to be drawn of neonate behavior should present, not a collection of isolated responses, but rather a delineation of the features of the ensemble in their inter-relations. In short, the parts are to be featured as they actually occur, namely, in an organization

When the responses with greatest frequency are considered, the amount of overlapping in the areas studied in this research is quite remarkable

The nature of segmental combinations or response patterns The responses with greatest frequency are, with one exception, those which are found in all thirteen areas (Table 3) Ft-fl leads, followed by T-x, Ft-fl, and Hal-x in the order named; then comes T-x-v, Ft-fl in eleven areas, followed by Hal-x, Ft-fl in twelve areas and T-fl in thirteen areas This, together with the remaining items in the table, demonstrates that Ft-fl is the most invariable segmental element found in the response patterns.

From the standpoint of individuated responses the foot, leg, and the hallux are outstanding, although it may well be questioned whether such segmentally limited responses all have the same developmental significance. Upon the basis of Minkowski's (3) and Bersot's (1) studies it seems probable that flexion of the foot, of the foot and leg, and of the foot, leg, and thigh are ontogenetically older responses than Hal-x which appears to be the latest individuation in this sphere of action.

Mixed types of toe responses, with extension succeeding flexion or vice versa, or extension of one or more toes accompanied by flexion of the others, may well represent transition stages in development as Bersot has claimed

Conclusions

1. *Limitations upon the Segmental Patterning of Responses.*

a. Out of 1581 responses to stimulation of 13 different cutaneous areas, only 185 different segmental patterns of response were discovered.

b Twelve response patterns or 6% of the patterns accounted for 50% of all responses, 27 or 15% of the patterns accounted for 75%, and 4 (2%) of the patterns for 29% of all responses

c. For the neonate to manifest the maximum of variability in responses would require that the number of response patterns *approach*, within the scope of the sample, the mathematical limits to the possible combinations of segmental movements In this instance the mathematically possible combinations number 6560.

d. The fact that 4 (2%) of the response patterns—accounting for 29% of all responses—occur to stimulation of thirteen different areas, that 12 (6%)—accounting for 50% of the total responses—extend to stimulation of at least 10 different areas, and that 27 (15%)—accounting for 75% of all responses—extend to at least 7 different cutaneous regions, is sufficient evidence for the assertion that there is little rigid, specific limitation of the reflexogenous zone

2. *The Reflexogenous Zone and the Segmental Patterning of Responses.*

a. Measured in terms of the number of response patterns the plantar areas are most generalized, with approximately 60 patterns, and the T2 dorsum least generalized with 28 different response patterns.

b. The same general trend is disclosed by the number of patterns which are unique to given areas

c. In terms of the concentration of response frequencies within a limited number of patterns, it is found that the *Rt plant. med.* is most generalized, since it requires 8 patterns to provide 50% of the entire responses; whereas the *hal. plant s.* is most specific, since it needs only 3 patterns.

d. A similarity in the response pattern frequencies for different areas serves as evidence that points within a single stimulogenous zone have been explored.

e. A marked disparity or a shifting in the relative frequencies of response patterns, in connection with stimulation of different

areas, demonstrates zones of secondary differentiation or even indicates the existence of other stimulogenous zones.

3. *The Segmental Patterns of Response.*

a. There is no one response pattern which may be termed the plantar response.

b Stimulation of a particular area may release several patterns of response

c Stimulation of different areas may evoke the same response or responses

d. The patterns of response occurring most frequently are. (1) Ft-fl (2) T-x, Ft-fl (3) Hal-x (4) T-x-v, Ft-fl (5) Hal-x, Ft-fl (6) T-fl (7) T, Ft-fl and (8) T-x and (9) T-x, Ft, L-fl, listed in descending order

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LA GÉNÉRALISATION ET LA SPÉCIFICITÉ DE LA RÉPONSE PLANTAIRE CHEZ LES NOUVEAU-NÉS LA ZONE RÉFLEXOGÈNE II LA CONFIGURATION SEGMENTAIRE DES RÉPONSES

(Résumé)

L'auteur a étudié la configuration segmentaire des réponses plantaires chez 55 nouveau-nés âgés de 1 à 21 jours On a stimulé treize aires cutanées (y compris la ligne médiane plantaire) de l'extrémité inférieure au moyen d'un contact caressant avec un contrôle partiel des facteurs de pression et de temps. On a observé huit segments pour le caractère du mouvement, la participation ou non-participation dans la réponse.

En l'absence des facteurs limitants anatomiques et physiologiques la variabilité de la configuration s'approcherait des limites mathématiques—dans cet exemple il y a 6560 combinaisons possibles Dans un total de 1581 réponses on n'a observé que 185 configurations segmentaires différentes

Il n'existe pas de haut degré de spécificité des reponses pour des aires spéciales de stimulation Six pour cent des configurations, s'étendant à 10 aires différentes, ont expliqué 50% des réponses totales En termes des configurations des réponses et des fréquences des réponses les aires plantaires sont les plus généralisees, tandis que la surface plantaire de l'hallux est la plus spécifique

On ne peut appeler aucune seule configuration de réponses *la* réponse plantaire parce que la stimulation d'une certaine aire peut faire se montrer une de plusieurs configurations de réponse tandis que la stimulation d'aires différentes peut évoquer la même réponse ou les mêmes réponses

PRATT

VERALGEMEINERUNG UND SPECIFIZITAT DES FUSSOHLENREFLEXES. DIE REFLEXOGENE ZONE II SEGMENTALGESTALTUNG DER BEWEGUNGEN

(Referat)

Der Verfasser untersuchte die Segmentalgestaltung der Fussohlenreflexe bei 55 neugeborenen Kindern 1-21 Tage alt Dreizehn Hautflachen (einschliesslich der Fussohlenmittellinie) des Untergliedes wurden durch Streichen bei einer Teilkontrolle des Druckes und der Zeitfaktoren gereizt Acht Segmente wurden hinsichtlich der Natur der Bewegung, Teilnahme oder Nichtteilnahme an der Bewegung beobachtet.

Bei der Abwesenheit von anatomischen und physiologischen einschränkenden Faktoren wurde sich die Variabilitat der Gestaltung den mathematischen Grenzen nahren Bei dieser Untersuchung gab es 6560 mogliche Verbindungen Bei einer Gesamtzahl von 1581 Bewegungen wurden nur 185 verschiedene Segmentalgestaltungen der Bewegungen beobachtet

Es gibt keinen hohen Grad der Spezifizitat der Bewegungen fur bestimmte Flachen der Reizung Sechs Prozent der Gestaltungen, uber 10 verschiedene Flachen ausgebreitet, entschloss 50% der Gesamtzahl der Bewegungen In bezug auf die Bewegungsgestaltungen und Bewegungshaufigkeiten waren die Fussohlenflachen am meisten generalisiert, wahrend die Fussohlenflache der grossen Zehe spezifischer ist

Keine einzige Bewegungsgestaltung darf als *die* Fussohlenbewegung bezeichnet werden, weil die Reizung einer bestimmten Flache ein von meheren Bewegungsgestaltungen erregen kann, Wahrend die Reizung von verschiedenen Flachen dieselbe Bewegung oder dieselben Bewegungen erzeugen mag

PRATT

FIRST YEAR DEVELOPMENT OF A RHESUS MONKEY (*Macaca mulatta*) REARED IN ISOLATION

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"Nothing is constant but change," and even change occurs at differential rates The phenomenon of change is evident in all sciences, but nowhere does it assume more importance than in biology and its related fields Here the problem is that of *growth*, and many current laboratory investigations deal with the mechanics, physiology, and pattern of development Both the structural, or morphological, and the functional, or behavioral, aspects of the problem are being investigated, with the consequent formulation of natural laws of sequence Thus growth is a central and unifying concept or problem, since it appears and can be studied in all forms of life Certain misguided individuals, however, have endeavored to overgeneralize and to contend that the same equations which hold for the morphological development of a given unicellular animal also hold for the growth of intelligence or for the growth of populations Less statistical formulation and more adherence to empirical observation would obviate this difficulty at the outset

The problem of growth may be studied from several different aspects The sciences of anatomy, physical anthropology, embryology and genetics, histology, neurology, biochemistry, biometry, developmental physiology, cultural anthropology, sociology, psychobiology, and comparative psychology are all interested in developmental mechanics. For the psychologist, the problem of growth resolves itself into an investigation of the developmental nature, origin and *modifiability* of organic behavior Growth is thus viewed from the dynamic and historical aspect of behavior—as a series of responses or behavior changes which constitute the reactional biography of the individual organism.

The recent trend in psychology and related sciences has been

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[1]Acknowledgment is gratefully made to Dr C G Hartman of the Department of Embryology, Carnegie Institution of Washington, Baltimore, Maryland, for the donation of the subject of known gestation age, and to Dr C J Warden, of the Laboratory of Comparative Psychology, where the investigation was carried out

toward placing more and more emphasis upon the early part of the life cycle or "activity stream," as the work of Watson, Gesell, and others will testify It should be noted, however, that studies of mental development have usually dated from birth The only real justification for such procedure is lack of knowledge of the prenatal age of the animal studied, or the enormous difficulties associated with work prior to parturition. Fertilization and not parturition marks the beginning of behavior as well as of morphology, and the fullest account of development must ultimately deal with the germ, embryo, and fetus as well as with the organism in senescence and decline, all of these periods being regarded as mere convenient portions of the developmental continuum This fact is all the more important since "birth" occurs at relatively different times for different species, so that valid interspecies comparisons must necessarily be made only with reference to the entire ontogenetic cycle Gestation, birth, longevity, size, and the acquisition of abilities vary significantly in their time relations for different species A further relevant fact to be considered is that reactions often disappear as well as appear during the early life cycle, Watson finding, for example, that the grasping reflex in human infants normally disappears at the postnatal age of 124 days.

Thus it is obvious that complete genetic cycles should be worked out before interspecies comparisons can be made. Interpretation of a given present reaction can correctly be made only in the case of an organism whose past reactions have been carefully observed from day to day, i.e., the actual "meaning" of any reaction can be appreciated only in terms of its genetic configuration. Otherwise any generalization is impossible

The above facts, especially when viewed in relation to the recent experiments on the conditioned response, emphasize the need for increasing genetic study by pushing investigations further and further back into the individual life cycle, i.e., the need for experimental investigation of prenatal behavior equipment Many reactions undoubtedly begin before birth since they are present even in individual organisms born prematurely Much is to be expected from future experiments in the field of prenatal conditioning. The term "maturation" has often been used in this connection, but it is the writer's contention that although the term may well be applied to the mere development of morphology, it usually is but a poor

excuse for psychological ignorance, since when the actual operative factors contributing to the behavior in question are known, the term is no longer applied.

It is obvious that along with universal interest in genetic development would come the construction of techniques for measuring such development. This research has been done primarily on the human infant, for whom the work of Gesell (7) is typical The general plan has been to investigate the growth characteristics of the infant by means of a series of standardized developmental examinations and by clinical case study, the standardization being sufficiently discriminating so as to define certain significant individual differences or deviations Rigid control of developmental observation has been employed, including the use of photographic methods The use of the "short-sample technique" and of the "infant development recording schedule" has given data on the monthly increments of development in human infancy, so that normative summaries have become available for various age levels.

All organisms are under the necessities and limitations of growth Although the vast bulk of such material has been on the human infant, a few attempts have been made to investigate the genetic development of other species. In regard to the study of infancy as a comparative science, Gesell (6, p 336) states. "In spite of the bewildering diversity of the behavior traits of the young of widely varying species, it is not improbable that there are certain orders of emergence and sequences of pattern which are common to all" Gesell (p 340-341) has compiled a developmental log of the golden eaglet, using the observations and photographs of Macpherson (20) Beginning with its powerful clutching reactions at the postnatal age of 1 week, the behavior series progresses to the fully developed hunting reactions at the age of 12 weeks, at which time the eaglet is buffeted by the parents and driven forcibly from the home nest

Many important investigations have been made of the behavioral development of mammalian forms Mention can here be made of only a few of the more outstanding and representative of these studies The intensive work of Coghill (4) upon the amphibian *Amblystoma* is well known Avery (2) has experimentally removed embryos of the guinea pig from the uterus at various levels of maturity, thus determining the exact time of appearance of dif-

ferent reflexes. Tilney and his associates (28, 29, 30), in a highly elaborate approach to the problem of behavioral development, especially in relation to the functional development of the brain, have constructed schedules of the progressive developmental process in several different mammalian species The methods employed embrace direct observation, cinematographic recording at normal and ultra-rapid rates, as well as the introduction of numerous experimental conditions and tests. The resulting "activity streams," which have already been reported for the albino rat, cat, and guinea pig, show the exact age levels at which various reflexes and basic reactions appear during the genetic cycle. Different activities are found to begin at different ages, and the order of appearance varies with the species. Nor should we neglect the recent work of Coronios (5) on the development of behavior in the fetal cat. Charts are presented showing the development of certain reactions at various gestation ages, and depicting cephalo-caudal development and the individuation of behavior in the extremities and special body areas Lastly, may we but mention the comprehensive studies of Minkowski (22) on the embryonic, fetal, and postnatal development of man

In the higher chordates, the postnatal period of immaturity becomes a recognizable part of the organismic life cycle The characteristics of infancy among the higher mammals, especially the primates, argue for an intensive comparative study In fact it is in the monkeys and apes that one can best investigate the psychological homologues of human behavioral development Schultz (26, p 61) says.

> The problems of human ontogeny and phylogeny will never be solved by the study of man alone, but are largely dependent upon new and more adequate data on the growth and evolution of all the primates Since any phylogenetic change has to affect primarily the processes of growth, additional information on the developmental changes in monkeys and apes is one of the first requirements for a thorough appreciation of the peculiarities of human growth, which have separated man and the anthropoids

Definite data in regard to the natural life histories of monkeys and apes are surprisingly meager Yerkes (42), perhaps more than any other one, has stressed the psychological importance of this field of study, although Hartman, Schultz, and others have

approached the problem from the viewpoint of developmental morphology and physiology. It was pointed out at an early date that a comparison of the life histories of monkeys and apes seems to emphasize the significance of the prolongation of human infancy. In 1869, A. R. Wallace (35), for example, compared the behavior of a young hare-lip monkey (*Macacus cynomolgus*) with that of a baby Mias, or orang-outang, which he had captured in the Malay Archipelago, pointing out the contrast between the relatively helpless Mias and the more fully developed monkey.

Among the earliest and most complete observations upon the young monkey are those of Cuvier. Brehm (3) gives the following quotation from Cuvier. It gives an interesting but anthropomorphic picture of the development of an infant rhesus macaque, in its intimate interactions with its mother:

> Immediately after birth the young Bunder (M. rhesus) clasped himself to his mother's breast, holding to her hair with all four hands and seizing her nipple in his mouth. For fourteen days he did not leave his mother's breast. He remained, always in the same position, always ready to suckle, sleeping when the adult sits down, yet clinging fast to her even in sleep. He released one nipple only when he wished to grasp the other, and so the first few days of his life passed without his having made a single movement except those of the lips, to suck, and of the eyes, to look about. Like all apes he was born with open eyes, and it seems that from the first movement he was able to distinguish his surroundings, for he followed every movement about him with his eyes.
>
> It is impossible to describe the care which the mother took for everything which concerned the feeding and the safety of her newborn. She appeared always intelligent, and so cautious as to compel admiration. The slightest noise, the least movement aroused her to watchfulness and to anxiety for her young one, not for herself, for she was accustomed to men, and had become quite tame. All her movements were performed with the greatest dexterity, yet never so that her suckling could have come to any harm. The weight of her young one seemed in no way to hinder her movements, and no difference in her dexterity or activity was noticeable. But indeed it was apparent that she took great care not to strike her baby against anything. After about fourteen days he began to leave his mother and showed, even in his first steps, a dexterity and strength, the more astonishing since neither practice nor experience could account for

it The young Bunder, from quite the beginning of his active life, climbed the upright wire grating of his cage and scrambled up and down at will; he made also a few steps on the straw, sprang voluntarily from the height of his cage, alighting upon all four hands, then against the grating up which he climbed with the ease and rapidity which had been noted in the adult. The mother followed every movement of her child with the greatest anxiety and seemed always ready to ward off any harm from her loved one Later she sought, from time to time, to relieve herself of the burden, but always remained watchful, and at the slightest sign of danger snatched him up immediately. The slightest touch of her hand was also a signal to her ready pupil to return, and he would instantly take his accustomed position on his mother's breast The leaping and play of the little animal became more perfect as his strength increased. I have often observed his merry gymnastics with the greatest delight and can attest that I have never seen him make a false movement, or fail to take measure of and reach the point for which he aimed. The little ape gave me certain evidence that he could estimate distance and control the requisite degree of strength for each of his leaps From the first moment he knew his natural movements and how to accomplish by them what another animal, even though possessing the intelligence of a man, could have done only after countless trials and long continued practice Here, indeed, one may ask: What can we say in explanation of the actions of animals?

After about six weeks a stronger nourishment than milk was necessary to the little ape, and here appeared a new phenomenon Both animals showed a different aspect of their mental processes The mother whom we saw before occupied with the most loving care for her offspring, who carried him constantly hanging to her body and breast, and of whom one would believe that, driven by maternal love, she was ready to give him the last bite from her own mouth, the same mother did not allow him to touch the slightest bit of food offered to him As soon as the keeper had given them bread and fruit she took possession of it, thrust the young one away when he wished to eat, and hastily filled her cheek pouches and hands, so that there was nothing left for him. It would be a mistake to believe that a nobler motive than gluttony impelled her to do this act. She could not have wished to force the young one to suck, for she had no more milk, no more could it have been care lest the food should be in-

> jurious to him, for he ate it greedily and thrived on it Hunger now soon made him very bold, venturesome and nimble He could no longer be driven back by the mother's blows, and in spite of everything that she could do to keep her child at a distance and keep all for herself, the young one was always sly and quick enough to snatch one or another bit of food and to bolt it behind her back and as far from her as possible This foresight was by no means unnecessary, for several times the mother ran to the furthest corner of the room in order to snatch back the food from her child In order to ward off the results which must follow this unmotherly behavior we provided more supplies than the mother could eat or conceal in her mouth and in this way the baby was provided for Thereafter he lived in good health and was fostered by his mother so long as he did not interfere with her food He distinguished rather well people who fed or petted him. He was always good-natured and, of the ape characters, showed only playfulness and agility.

Another early anecdotal sketch of the infant macaque, in its natural habitat, is that of Ram Bramha Sányál (23) :

> The young monkey after birth attaches itself to its mother, and will not leave her for nearly a month, the mother nursing the young all the time with the utmost solicitude, after this time it will make little excursions on its own account, but is careful not to stray far, and at the slightest sound or movement it seeks refuge with her The mother is unremitting in her vigilance over her offspring and in its personal wants and appearance Compared with an orang-outang of the same age, a monkey is more helpful and intelligent, and in fact all its instincts are strongly developed at a comparatively early age In about a month the young one begins to pick up grain and other food, and then the struggle for life soon begins, and the mother and the young one commence to fight over their food, although their natural instincts bind them to each other at other times

Kuroda (18) has reported a brief investigation of the physical and sensori-motor organization and development of a newborn *Macaca irus* (*M cynomolgus*) monkey. Relevant material from this study will be considered below.

Lashley and Watson (19) have presented the diary of the growth and behavioral development of a young *Macacus rhesus* monkey The animal remained with its mother in captivity, and the observa-

tions covered a period of four months, dating from birth Gesell (6, p. 345) has taken these data and recapitulated the course of development in tabular form. In drawing up this table, Gesell has assigned the approximate age at which a comparable motor ability or behavior event occurs in the life cycle of an average human infant, basing the age assignments on his normative data

Tinklepaugh and Hartman (11, 32, 33), in a series of three investigations, although primarily interested in the behavioral aspects of parturition and the behavior and care of the newborn, have nevertheless presented much relevant and important material on the actual behavioral development of the young rhesus monkey itself, in its constant relations and interactions with its mother. These studies, together with that of Lashley and Watson, represent the most comprehensive work in this field to date Only strictly "normal" development was studied, since the infants were never segregated or isolated from the mother. We shall have occasion to make frequent reference to this material when considering the results of the present investigation.

The question of the comparative aspects of infancy in primates is an old one, for interest has always centered in the extent of the influence of domestication or in the degree to which civilizational stimulation determines the behavior of man or the higher animals. Occasionally has the psychological question been reversed, as in the fictitious Tarzan of the Apes, Romulus and Remus, and Kipling's Mowgli, and in the scientifically authenticated cases of Itard's "wild boy of Aveyron" (13), Kasper Hauser (34), and the "wolf children of India" (15, 27) Kellogg and Kellogg (16) have recently attacked this problem of "Nature vs Nurture" by attempting to rear an infant chimpanzee with a human child for a period of 9 months, giving both subjects the same stimulation and training, and recording the respective reactions and behavioral development Thus there was a definite attempt at "humanization."

One of the earliest reports of an attempt to rear a primate in isolation is that of A R Wallace (35) mentioned above, who worked with an infant Mias or orang-outang in the Malay Archipelago Since no milk was available, rice-water was used, with occasional additions of sugar and cocoa-nut milk, the liquid being administered from a bottle with a quill in the cork, although after the first few weeks more varied and solid food was employed. Wallace states:

When handled or nursed, it was very quiet and contented, but when laid down by itself would invariably cry, and for the first few nights was very restless and noisy. I fitted up a little box for a cradle, with a soft mat for it to lie upon, which was changed and washed every day, and I soon found it necessary to wash the little Mias as well. After I had done so a few times, it came to like the operation, and as soon as it was dirty would begin crying, and not leave off till I took it out and carried it to the spout.

For the first few days it clung desperately with all four hands to whatever it could lay hold of, and I had to be careful to keep my beard out of its way, as its fingers clutched hold of hair more tenaciously than anything else, and it was impossible to free myself without assistance. When restless, it would struggle about with its hands up in the air trying to find something to take hold of, and, when it had got a bit of stick or rag in two or three of its hands, seemed quite happy. For want of something else, it would often seize its own feet, and after a time it would constantly cross its arms and grasp with each hand the long hair that grew just below the opposite shoulder. The great tenacity of its grasp soon diminished, and I was obliged to invent some means to give it exercise and strengthen its limbs. For this purpose I made a short ladder of three or four rounds, on which I put it to hang for a quarter of an hour at a time. At first it seemed much pleased, but it could not get all four hands in a comfortable position, and, after changing about several times, would leave hold of one hand after the other, and drop on to the floor. Sometimes, when hanging only by two hands, it would loose one, and cross it to the opposite shoulder, grasping its own hair, and, as this seemed much more agreeable than the stick, it would then loose the other and tumble down, when it would cross both and lie on its back quite contentedly, never seeming to be hurt by its numerous tumbles. Finding it so fond of hair, I endeavored to make an artificial mother, by wrapping up a piece of buffalo-skin into a bundle, and suspending it about a foot from the floor. At first this seemed to suit it admirably, as it could sprawl its legs about and always find some hair, which it grasped with the greatest tenacity. I was now in hopes that I had made the little orphan quite happy; and so it seemed for some time, till it began to remember its lost parent, and try to suck. It would pull itself up close to the skin, and try about everywhere for a likely place, but, as it only succeeded in getting mouthfuls of hair and wool, it would be greatly disgusted, and scream violently, and after two or three attempts, let go altogether.

Another somewhat similar but unrecorded situation has come to the attention of the writer. This is that of John T Benson, of Nashua, New Hampshire, American representative of the firm of Carl Hagenbeck, Hamburg, Germany, relative to the rearing of an infant *Macacus rhesus* monkey, first in isolation, and then with a group of chimpanzees. The young animal was removed when still immature from the mother by Caesarean operation, after the mother had hanged herself Although anecdotal, the material is not without value. In a personal communication to the writer, Mr Benson writes as follows:

> We took a cigar show case, and put an electric light in the humidor part of it This made a very good incubator The baby monkey was kept in this from about two hours after it was born on May 20, 1933, until we sold it on September 29th This incubator had glass all around the sides and was kept on a little table about two feet away from the outside cage which we use for training our young chimpanzees
>
> At birth, it was given a few drops of whiskey and milk diluted with water about every two hours. The next day it was fed with an eye dropper on cow's milk diluted with water. It was fed this way until it was sold. The last two weeks we had it, it was given a little cream of wheat with a spoon and a little rice and tapioca pudding
>
> About the first week of August, the maid, who had the care of it, took it into the chimpanzee's exercising cage. It was accustomed to cling to the arm the same as a baby Rhesus hangs onto its mother She could wash and clean out the incubator —the glass part—and change the little pillow we had for it and do all her work around the cage with the little thing clinging to her arm The first time she took it into the chimpanzee cage, it was several minutes before the little thing would let go of her arm
>
> In a little while, I understand, the monkey started to move around with a loping motion, not walking on its hands and feet, but loping similar to a frog I saw it do this many many times In a few days, the maid decided to see what the smallest chimpanzee we had would do with it, so we had both of them together in this cage For something like two mornings the chimpanzee was afraid of it, but gradually became acquainted with it From then on, the two were put together about half an hour every day, with the maid in attendance. This baby monkey always loped when it moved. About the last three weeks

> we had it, it walked on its hind legs with its hands up . . . it was bathed every morning just the same as a baby would be. When the maid would be drying it and move it around, it was naturally stood on its hind feet This is a habit they have with our chimpanzees in order to train them to walk erect The baby Rhesus learned to come up for his bath and knew when it was feeding time and sucked its thumb. He got along splendidly with the three baby chimpanzees we have here. They pulled it around more or less, but never hurt it

Another such unpublished attempt at rearing an infant monkey in isolation was that done under the supervision of Dr E T Engle, of the Department of Anatomy, College of Physicians and Surgeons, Columbia University. The infant was a female macaque, Doris, born on May 5, 1932 Its mother, purchased from Bartels, New York City, nursed it for three days, after which she refused to claim or suckle it. Thus it was removed and kept in isolation from that time The length of gestation was unknown. This animal is still alive and in excellent condition, and is at present housed with other members of the primate colony, after 1½ years of isolation Daily behavioral development was not recorded, although reflexes were periodically investigated We shall have occasion, however, to point out below a few interesting similarities of reaction to those exhibited by the subject of the present investigation

Perhaps the most complete study of primate development is that of Jacobsen, Jacobsen, and Yoshioka (14) on the development of an infant chimpanzee during her first year. This animal was born at the Yale Experiment Station in Orange Park, Florida, and the monograph includes detailed accounts of the habitat, dietary, and health, in addition to accounts of physical growth and behavioral development Due to illness and subsequent death of the mother 15 days after parturition, the infant chimpanzee was kept isolated in the Station for the first 15 days, after which it was taken to the residences of Staff members, although no attempt was made at "humanization" From the ninth month until the end of the first year, the animal remained at the Experiment Station.

Problem

The present investigation grew out of an interview with Dr. Carl G Hartman, of the Department of Embryology, Carnegie Institution of Washington, Baltimore, Maryland Both Dr. Hartman and

the writer were interested in the feasibility of rearing an infant monkey from birth in complete isolation from its mother and other members of the species Since a large colony of mature monkeys was available, and since breeding was frequent and controlled, it at once appeared that the situation was ideal for such an attempt The writer is under the deepest obligation to Dr Hartman, both for his donation of a subject of known gestation period, and for the untiring suggestions and cooperation which he has given throughout the present investigation Acknowledgement is also made to Dr C J Warden of the Laboratory of Comparative Psychology of Columbia University, where the study was carried out

The subject of the present investigation was a male *Macaca mulatta* or "Rhesus" monkey, who was subsequently given the name "Kras" The animal was born in the Laboratories of the Department of Embryology, Carnegie Institution of Washington, Baltimore, Maryland, being the son of No. 106 of that primate colony Birth occurred in the early morning of October 9, 1932, after a period of gestation of 167 days The infant was forcibly taken from the mother on the morning of October 12, three days after birth, and transported by automobile directly to New York, where it has since remained in the Laboratory of Comparative Psychology of Columbia University. Throughout the following one-year period with which this report deals, there was no attempt at tuition, nor was the monkey reared as a pet In fact, contact with humans and other animals was kept at a minimum, involving only the feeding and observational periods

It should be emphasized that the task was attempted primarily as an exploratory investigation or pioneer study, the object being to test the feasibility of rearing an infant monkey in isolation, with the attending problems of diet, housing, and general care All other purposes were subordinated to this primary aim. Observations of the more complex psychological behavior are thus often sketchy and fragmentary rather than final and conclusive, and will perhaps raise more questions than they answer. Since the infant did survive and develop in a manner exceeding all expectations, the primary purpose of the study has been realized, and we can look forward to the future utilization of the infant *Macaca mulatta* monkey in an attack upon many of the intriguing problems of psychology, only a few of which have been mentioned in the preceding section.

Habitat

The infant monkey reached the Columbia Laboratory on the afternoon of October 12, having been transported by automobile from Baltimore in a standard albino rat cage, 18½ x 11¾ x 11½ inches, with hinged front of ¼-inch wire mesh. Several sheets of paper toweling were placed on the floor of the cage, over which was spread a layer of heavy cotton batting. Loose pieces of cellucotton were laid on top to catch urine and feces. This cage, in which the monkey remained for the first week, was situated in a separate room of the laboratory, adjoining but isolated from the regular primate quarters. At night the cage door was covered with cloth in order to maintain a constant temperature. On the coldest nights, additional warmth was obtained from a 40-Watt mazda bulb. This was seldom necessary, however, since diurnal variations in temperature were small, due to the presence of heat in the laboratory at all times.

On October 19, Kras was transferred to the standard rabbit or guinea pig cage, 22 x 30 x 24 inches, with top, hinged front, and part of the sides of 1-inch diamond mesh. The toweling, cotton batting, and cellucotton were used as before. On December 4 the batting and cellucotton were removed and the regular sawdust tray inserted in the bottom of the cage. A wooden shelf, 1 foot wide, was also inserted in the rear of the cage, approximately 5 inches from the floor. On February 18, this shelf was removed, and the regulation ¼-inch galvanized grill floor was inserted into grooves above the sawdust floor pan. The entire cage was subsequently transferred to another room which admitted of direct sunshine and which was also more accessible to laboratory workers, with attendant increased visual stimulation for the animal.

Finally on March 11, the monkey, then over 5 months old, was transferred to a standard monkey cage in an isolated part of the primate room. This cage was 28 x 35½ x 34 inches, with a front door of 1-inch diamond mesh, and with wooden shelf 18 inches above the floor. A ¼-inch galvanized grill floor was situated above the sawdust floor pan. This cage thereafter constituted the animal's permanent quarters.

In addition to the batting, cellucotton, and wooden shelf mentioned above as accessories within the cage from time to time, the following objects were also available to the animal. A linen towel

was often inserted through the grating on the side or top of the cage, so that the development of climbing and swinging reactions might not be prevented or impeded A round hardwood ball, 1½ inches in diameter, was available periodically from the second month The rubber nipple from the nursing bottle was often retained in the cage for teething or manipulation, as was the milk or food container at a later date The above, together with the food itself and the observer's hand and fingers, were the only extraneous manipulatory stimuli with which the infant was normally confronted, with the exception of the brief observation periods, when other objects and animals were employed. The subject enjoyed a daily 30-minute period of Sunlamp stimulation throughout the year.

Dietary

Although Kras had been suckled by his mother during the first three days of life, no unusual difficulty was encountered in the introduction of artificial feeding. The development of feeding reactions will be considered below A general summary of the dietary and feeding schedule is given in Table 1 below

The milk preparation used during the first 4 months consisted of a 50% solution of evaporated milk and pure water, sweetened with sugar The orange juice for these periods was likewise of 50% strength, and was strained and sweetened. From the fifth to seventh month, pasteurized cow's milk was employed. For the eighth month and following periods, milk and eggs were mixed in the proportions of 2 eggs per quart of milk All milk preparations were heated before use.

During the first 7 months, Mead's standardized Cod Liver Oil, biologically assayed for anti-rickets Vitamin D and anti-xerophthalmia Vitamin A, was used. The dose was 1 teaspoonful per day for the first 2 months, and on alternate days from months 3 to 7 Beginning with the eighth month, a cod liver oil preparation was employed, made from Squibb's Adex Tablets, with Viosterol, 10 D, powdered and mixed with Lactophos (bone meal). The evening ration of banana was partially slit longitudinally and a small amount of this powder sprinkled inside In this way, the compound could be administered daily without any trouble or inconvenience whatsoever.

Solid foods could no doubt have been administered earlier, but it

TABLE 1

DIETARY AND FEEDING SCHEDULE

First Month:	A.M.	8:00	Warm water
		9:00	Milk
		11.00	Orange juice
	P.M.	1:00	Milk
		3:00	Orange juice
		5:00	Milk
		8:00	Orange juice
		11:00	Milk
Second Month	A.M.	8:00	Milk
		11.00	Milk
	P.M.	2:00	Orange juice
		5:00	Milk
		8:00	Orange juice
		11:00	Milk
Third and Fourth Months	A.M.	8:00	Milk
		12:00	Orange juice
	P.M.	5:00	Cereal (Farina, Cream of Wheat, Oatmeal)
		11:00	Milk
Fifth to Seventh Month	A.M.	8:00	Wholewheat bread
		10:00	Milk
	P.M.	1:00	Orange juice
		6:00	Milk
Eighth Month and followings			Standardized Columbia Weekly Feeding Schedule for Monkeys

	8:00 A.M.	*1:00 P.M.*	*6:00 P.M.*
Monday	Milk & Eggs	Boiled rice, Celery	Banana
Tuesday	Milk & Eggs	Boiled potato, Beet	Banana
Wednesday	Milk & Eggs	Wholewheat bread, Lettuce	Banana
Thursday	Milk & Eggs	Boiled rice, Spinach	Banana
Friday	Milk & Eggs	Wholewheat bread, Celery	Banana
Saturday	Milk & Eggs	Boiled sweet potato, Carrot	Banana
Sunday	Milk & Eggs	Wholewheat bread, Lettuce	Banana

Also small amounts of apple, orange, raisin, sunflower seed, and peanuts

was deemed better not to introduce them so soon. The above schedule was compiled both from preliminary study and consultation and from empirical experimentation. It proved extremely satisfactory, for at no time did the animal suffer from severe diarrhea or show any pathological symptoms.

During the first 4¼ months (from October 12 to February 17), the milk and orange juice preparations were administered by means of a 4-ounce Pyrex glass nursing bottle with attached small size Santro rubber nipple. Subsequent to this time, the milk was drunk (at first "eaten") from a small aluminum pan The cereals fed during the third and fourth months were eaten from a saucer, whereas the solid foods were either taken directly from the floor of the cage or from the hand of the experimenter. More will be said below concerning feeding behavior.

Discussion of Results

Since space will not permit inclusion of all daily observations, and since the notes on many phases of development are at times necessarily superficial, an attempt will be made merely to summarize a few of the more important findings It is obvious that at the beginning of such an experiment little is known of what may follow, and the investigator can but do his best to observe the variable and ever changing panorama of behavior. At the conclusion, he can glance back over the data, note the development of certain reaction systems, and draw any inferences or interpretations which seem justified in the light of actual results In the following discussion, many data are incomplete and unconvincing, and many omissions will necessarily occur Repetition and overlapping will also creep in, since many of the observations bear on more than one topic It is only hoped that these meager results will stimulate further research Discussion of the results has been divided into three sections, including (1) Physical Development, (2) Sensorimotor and Simple Behavioral Development, and (3) Complex Behavioral Development This classification, particularly of the last two topics, is more or less arbitrary, and is used solely as a matter of convenience

1 *Physical Development.* The period of gestation of the subject of this investigation was 167 days, 3 days more than the figure of 164 days given by Hartman (1932, 30 cases, cf 10) as the average duration of pregnancy in the rhesus macaque, but well within the usual range of the species On October 10, the day after birth, the infant weighed 420 grams. This corresponds closely with the findings of Schultz (10), who reports that the newborn *Macaca mulatta* weighs between 330 and 600 grams, according to records on 12 male and 12 female living newborns This weight is ordinarily from 6 to 10%

of the weight of the mother when not pregnant, although the proportion is somewhat higher in small mothers than in large ones The data of Schultz (10, 24) show that on the average, the weight at birth becomes doubled at the age of 5 months and quadrupled at the age of 15 months This conclusion also holds for the results of the present study. Table 2 shows the average weight of the subject for each

TABLE 2
AVERAGE WEEKLY WEIGHT DURING THE FIRST YEAR

Age*	Average weight (grams)	Age*	Average weight (grams)	Age*	Average weight (grams)	Age*	Average weight (grams)
1	422	14	797	27	983	40	1152
2	441	15	826	28	1042	41	1169
3	461	16	854	29	1064	42	1177
4	487	17	887	30	1077	43	1208
5	505	18	912	31	1082	44	1219
6	538	19	933	32	1042	45	1272
7	573	20	951	33	1081	46	1324
8	629	21	938	34	1114	47	1361
9	651	22	1001	35	1139	48	1432
10	683	23	1036	36	1160	49	1483
11	716	24	972	37	1153	50	1470
12	739	25	1000	38	1139	51	1496
13	780	26	988	39	1118	52	1580

*Successive 7-day periods

successive postnatal 7-day period of the first year. Daily measurements were taken for the first 27 weeks, after which the number of readings varied between 2 and 4 per week The figures presented are the averages of the readings taken for each successive week. These data are presented graphically in Plate I.

Schultz has found that at all ages, the body weight varies to a surprising degree from animal to animal. A glance at the graph, as well as inspection of the daily records which are not here included, shows that the same animal varies in weight from time to time Thus there are intra-individual as well as inter-individual weight variations Attention has already been called to the extremely rapid gain in weight of the subject. The curve, of which each point is a composite of several records, nevertheless shows surprisingly little variation for the first 5 months and for the last 3 months of the first year Such regularity would seem to indicate that the dietary and other such factors were relatively well controlled Whether

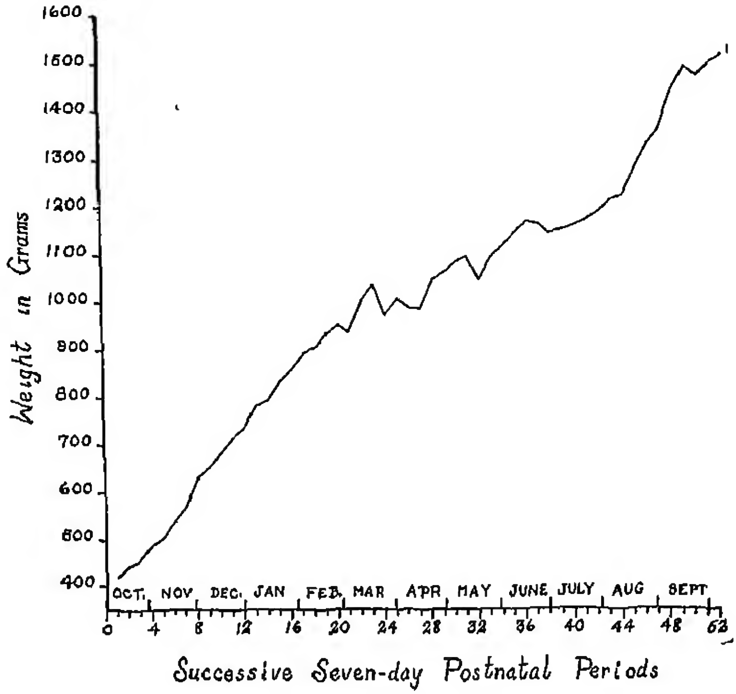

PLATE I
AVERAGE WEEKLY WEIGHT DURING THE FIRST YEAR

the variability is due to chance factors or to some organic processes cannot be determined More cases are needed, as well as more intimate and detailed analysis of physiological and anatomical correlates

Since the primary interest of this paper is that of behavioral rather than physical development, few other morphological indices need be included. Schultz has devised a standardized technique for measuring the outer body of living or dead primates. The measurements themselves, together with the proportions calculated from these measurements, have been described in detail in a special paper by that investigator (25). Various bodily dimensions are recorded, including sitting height, tail length, trunk height, chest circumference, chest breadth, chest depth, shoulder breadth, hip breadth, total

lower-limb length, thigh length, leg length, foot length, total upper-limb length, upper-arm length, forearm length, hand length, head length, head breadth, head height, average head diameter, total face height, and face breadth, together with various calculated proportions.

Schultz has found that the limbs grow faster than the trunk before birth, but more slowly than the trunk during postnatal life, this fact being demonstrated by the proportions between the total limb lengths and the trunk height After birth, Kras showed a disproportionately large head and ears, and the hind quarters were considerably smaller than those of the adult monkey These data corroborate those of Lashley and Watson (19). The infant's body was covered with hair at birth, distributed as in the adult, and rich brown in color. By the end of the fifth month, the hair on the head had parted longitudinally down the median line. The writer has frequently noticed this occurrence in other young monkeys The face and under surface of the hands and feet were bare and brownish red in color The fingernails were short and light pink The face was covered with the characteristic deep wrinkles, which became gradually less pronounced both in number and degree. The testes remained undescended during the entire year, but visible in the canal some distance above the scrotum. In three cases reported by Schultz (25), 34 months was the earliest time of descent of either testis, although both testes were back in the canal at the age of 38 months. "The permanent descent apparently does not take place before the middle of the sixth year"

Hartman (10, preface, viii) has pointed out that "up to the present time there have existed no reliable data for estimating even approximately the age of monkeys" Schultz (10) contends that such an estimation should be based not upon one variable such as weight alone, but upon weight and several other dimensions, in combination with the dentition. Thus aside from the aforementioned bodily characteristics, ossification of the bones and calcification and eruption of the teeth are to be considered if we are to get an adequate picture of the developmental status of an animal of unknown date of birth. The eruption of the teeth is itself an extremely variable process, however For a criterion of eruption, Schultz has used the time when the tooth has clearly pierced the gum, whereas Marshall (10), using X-ray evidence, has defined eruption as emer-

gence from the jaw-bone Table 3 gives the sequence and times of eruption of the deciduous dentition in the subject of the present investigation. The criterion of Schultz was employed.

TABLE 3
SEQUENCE AND AGE OF ERUPTION OF THE DECIDUOUS DENTITION

Sequence	Tooth	Age of eruption	
1.	Lower middle incisor	3	weeks
2	Upper middle incisor	3	"
3	Lower lateral incisor	5	"
4	Upper lateral incisor	5½	"
5.	Upper canine	13	"
6	Lower first molar	13½	"
7.	Lower canine	14½	"
8.	Upper first molar	15	"
9.	Lower second molar	24½	"
10	Upper second molar	26	"

The above data are of course not particularly accurate, due to the relative subjectivity of the criterion They are sufficiently accurate for practical purposes, however, and are similar to the results given by Schultz, being in most cases slightly higher than the reported average, although well within the range of distribution Schultz summarizes the results as follows: "All of the incisors erupt during the first six weeks, the canines and first molars are added during the twelfth to fourteenth weeks, and the second molars during the twenty-third to twenty-fifth weeks" No permanent teeth erupted during the first year, such teeth usually begin to appear in the twentieth month Thus, in conclusion, our data support the statement of Schultz (10, p. 23, footnote) that "captivity does not in any way influence the sequence of tooth eruption."

2 *Sensorimotor and Simple Behavioral Development* Correlated with the rapid growth in physical characteristics was an even greater and more astonishing increase in general behavior equipment. Figures 1-12 (Plate II) illustrated the development of general body structure and gross behavior, while the remaining 78 figures deal with more specific reactions. Reference will be made to appropriate figures from time to time. We shall confine our consideration almost exclusively to the *Macaca mulatta* in the present section, since data on other primate forms would complicate rather than clarify the exposition. If interested, the reader can find comparable material for the chimpanzee in the study by Jacobsen,

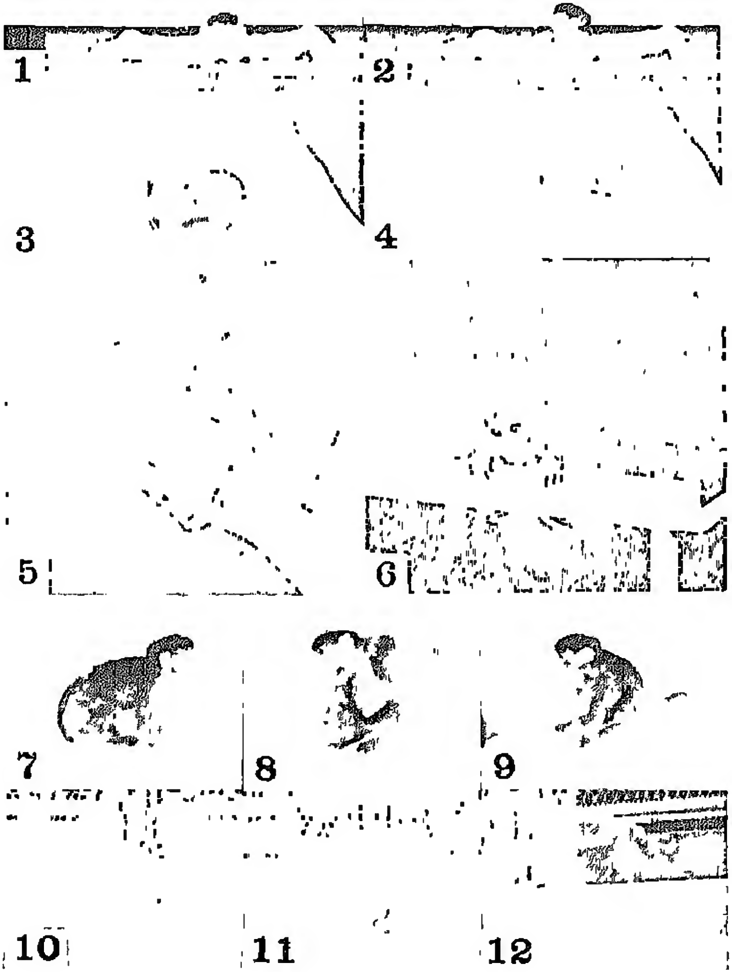

PLATE II

FIGURES	1- 2	21 DAYS
FIGURES	3- 4	47 DAYS
FIGURES	5- 6	119 DAYS
FIGURES	7- 9	247 DAYS
FIGURES	10-12	365 DAYS

Jacobsen, and Yoshioka (14), and for this and other infra-human primates in the volume by Yerkes and Yerkes (41). Relevant data on the human infant are reported by Gesell (6, 7).

Tinklepaugh and Hartman (11, 32), studying parturition in the rhesus monkey, have described the following behavioral factors: posture during labor, manual cooperation of the mother in delivery, cleaning of the baby, consumption of the afterbirth, disposal of umbilical cord, absence of vocalization, differences between multiparous and primiparous behavior, and individual differences and general behavioral patterns in parturition. They elsewhere (33) discuss, not only the behavior of the mother but also the reactions of the newborn infant without introduction of experimental factors such as isolation or segregation. Perhaps a brief consideration of their findings will be relevant. They state (pp. 265-266):

> Activity on the part of the typical monkey begins as soon as it is sufficiently free from the birth canal to make any form of movement possible. When the head appears, the eyes begin to blink and the baby gives shrill, piping sounds. The arms reach out and seize hold of any object within reach as soon as they are expelled. At times it appears that this behavior actually aids in the process of delivery. Once a body is free, the mother draws it around before her and begins the cleaning process. At this time, the baby indulges in violent seizing reactions with both hands and feet. When it is upturned it struggles to right itself. If held suspended in the air it grasps its own hands and feet, one in the other, or seizes its own body. If left on the floor momentarily . . . it stands up and attempts to walk. During, or soon after the cleaning process, the afterbirth is delivered and the mother's attention is directed away from the baby. At this time the young monkey executes the behavior which is the most important from the standpoint of its survival. The mother may hold the infant to her breast with one arm as she turns to this other activity. She does not otherwise determine the baby's position relative to her, but it *orients itself* toward her in the ventro-ventral relationship and clings tightly with both hands and feet. While the baby is in this position its mouth, which has been constantly opening and closing, explores through the mother's fur and bites down upon any area or object which it can reach in this manner. During the oral exploration the baby, quite by accident, it seems, comes in contact with the maternal nipple. Once this

> relationship is established the newborn baby devotes most of its waking hours clinging to the mother's breast with hands and feet and to the nipple with its mouth.

Thus the infant macaque finds the nipple by trial and error or random movements in much the same way as the marsupials, according to Tinklepaugh and Hartman. The behavior, including the licking of the fetal fluid from the baby and the consumption of the afterbirth by the mother, is regarded as a possible outgrowth of the mother's preparturitional manual exploration of the genital region and the licking of the fetal fluids from the hands "The baby clings tightly beneath the mother's breast either unaided or with the support of one of her arms." The mother picks through the infant's fur, removing all foreign objects and drying fetal fluids "When its fur is being picked through it lies quietly and permits itself to be turned over onto its side or back, or have its legs or arms stretched out or moved into almost any position The moment the fur picking or body examination ceases, however, the infant attempts to right itself and to renew contacts with its hands, feet, and mouth"

Finally, before considering the data from the present study, let us see what significance has been attached to the above mentioned reactions. As to the biological importance of these behavior patterns, Tinklepaugh and Hartman (p 282) point out that the fetal macaque is undoubtedly parasitic and that activity in the normal baby monkey may actually occur during the course of delivery They continue.

> It may reach out with its arms as soon as they are disengaged and seize hold of any objects in the immediate environment. It is conceivable that the baby born in the native state might in this manner support itself and thereby avoid falling from its arboreal birthplace But this grasping behavior serves still another purpose in the scheme of things in monkeydom If the baby is to survive, it must secure nourishment from the mother The mother gives manual aid to the delivery of her baby, brings it up before her, and there licks the fetal fluids from its body Regardless of its strength or weakness, factors commonly related to the conception-age of the baby at birth, the mother carries it with her But the baby itself, by its grasping behavior, determines its position relative to the maternal breast It orients and holds itself in the ventro-ventral relationship It explores the mother's fur with its mouth and discovers the nipple. Its behavior alone determines both how and when it

> shall take nourishment. In other words, behaviorally, and from a nutritional standpoint, the baby suckles the mother, the mother does not nurse the baby In that sense the baby remains parasitic even after birth

The early sensorimotor development of the infant *Macaca mulatta* is so rapid and complete that the usual Stimulus-Test methods, which must necessarily be employed, often fail to show exactly when the various modalities become completely functional. Since the more exact, training methods of testing receptivity, such as the Conditioned-Reflex, Discrimination-Response, or Complex-Task procedures, cannot be used, the specific stimulus can but be presented and the immediate gross or specific response of the animal used as an indicator. In Table 4 below are presented sensorimotor data from the present study together with those from the studies of Lashley and Watson (19) and Tinklepaugh and Hartman (33), the latter investigators giving data for 3 subjects. A considerable amount of discrepancy in these results will be noted, although this is to be expected from the nature of the data and the method of observation. Had our subject been available for observation before the third day, more data on several points could have been obtained.

Let us first consider *visual receptivity*. The *pupillary reflex*, involving constriction of the pupils to a flashlight stimulus, was first noted on the third day (L. & W., 2 days; T. & H., 3, 2, 2 days, respectively). The *lid reflex or winking response to random and to non-visual stimuli* was first noted on the third day, the first day of observation, although it was undoubtedly present prior to this time (L. & W., 1 day; T. & H., 1 day). Such a reaction occurred at random, being frequently made to no apparent external stimulus, and was also experimentally elicited from the first whenever contact was suddenly made with the face or eyes. The *lid reflex or winking response to a visual stimulus* appeared, as nearly as could be determined, on the tenth day (L. & W., no data; T & H., 8 days in one of 3 subjects). Tinklepaugh and Hartman (p 278) state:

> Though all of the babies we observed began to wink during or very shortly after delivery, they failed to respond in this manner on the basis of visual stimuli provided by objects moved rapidly toward or in front of their eyes. They did respond, however, whenever contact was made with the face or when the eyes were blown into.

TABLE 4

SENSORIMOTOR RESPONSES OF THE INFANT MACACA MULATTA MONKEY STATED IN TERMS OF THE DAYS OF THEIR APPEARANCE

			Visual sensitivity										Auditory sensitivity	
Investigator	Subject	Copulation age	Pupillary reflex	Lid reflex or winking response to random and to non-visual stimuli	Lid reflex or winking response to visual stimuli	Visual pursuit movements	Reaching or reflex grasping at visual stimuli	Nystagmus—rotation of visual field	Nystagmus—rotation of subject	Pain and tactile sensitivity	Olfactory sensitivity	Gustatory sensitivity	Pinna response	Start response
Foley	Kras	167	(3)	(3)	10	7	9	*	*	(3)	(3)	*	(3)	37
Lashley & Watson	unnamed	*	2	1	*	3	5	*	*	1	*	*	2†	*
Hartman & Tinklepaugh	Joshua	155	3	1	—	11	*	—	11	*	3	*	4	18
	Nina	168	2	1	—	5	*	—	7	*	2	*	2	10
	Pola	167	2	1	8	5	*	—	6	*	2	*	2	7

* No data reported
( ) First day of observation, possibly present earlier
† Pattern or indicator of response not reported

Visual pursuit movements were tested by slow movement of a flashlight stimulus across the infant's visual field, at varying distances from the eyes Neither the eyes nor head was turned to follow the moving stimulus until the seventh day (L. & W., 3 days; T. & H, 11, 5, 5 days respectively). *Reaching or reflex grasping at a visual stimulus* appeared at the age of 9 days (L. & W., 5 days, T. & H, no data). *Visual discrimination* was very poor during the first two weeks Evidence showing that, even at 47 days of age, visual discrimination was not commonly utilized in many cases will be presented in a later section dealing with feeding behavior (cf Figures 23-25). The present subject was not tested for *nystagmus* (L. & W, no data; T. & H., negative results in all 3 subjects on rotation of the visual field, but positive results when the subjects themselves were rotated, the nystagmus appearing at the ages of 11, 7, and 6 days, respectively). Thus our data, together with those of Lashley and Watson and Tinklepaugh and Hartman, indicate relatively slow development of the visual function in the *Macaca mulatta.*

Reactions to *pain* and *tactile stimulation,* administered by means of a needle and horse-hair point respectively, were present on the third day after birth, no observations having been made before this date (L. & W., 1 day; T & H., no data). Response to *olfactory stimulation,* bottles of camphor and dilute ether solution presented to the animal's nostrils, occurred on the third day and might have occurred sooner (L. & W., no data, T. & H, using oil of cloves, 3, 2, 2 days, respectively). There were no tests of *gustatory sensitivity,* although it appeared from the third day that the animal showed rough food preferences (L & W, no data, T. & H., no data)

In the field of *audition,* the *pinna response* was the first to be observed. This consisted of a sudden movement of the pinna of the external ear in response to a sharp whistle, the sound of a buzzer, or the striking of a steel bar, and was noted on the third day and consequently may have been present sooner (L & W., no data, although a "slight unadaptive response to sound" was reported at 2 days, T. & H, 4, 2, 2 days, respectively). The *start response* to these auditory stimuli, including a definite but non-violent general or molar reaction of the entire body, so characteristic of the average monkey, was not noted until approximately the thirty-seventh day (L. & W., no data, T. & H., 18, 10, 7 days, respectively) The

progressive sequence of development from the pinna response to the start reaction was not noted in the present subject. Tinklepaugh and Hartman (p. 278) report a "stepwise" transition from the pinna to the start responses as follows: "First there was ear movement; second, ear and head; third, ear, head and fore limbs, and finally, after intervals of from 5 to 14 days, the start response involved the entire body."

In Table 5 below will be found further data on the appearance of sensorimotor and simple behavioral responses. This table should be regarded as a continuation of Table 4 into the more predominantly motor or reactive fields of behavior.

A large percentage of the time of the young infant was spent in *sleeping*, which was first observed by the writer on the third day (L. & W., 1 day; T. & H., 1 day). Yerkes and Yerkes (42), after reporting that sleeping nests or beds are not constructed by the lemur, monkey, gibbon, or siamang, whereas all three types of great ape regularly build such nests, continue (p. 564):

> Monkeys . . . ordinarily sleep in sitting posture, supported or stabilized by hands and feet, whereas orang-outang, chimpanzee, and gorilla, like man, lie completely relaxed on back or side, often with the head pillowed on one or both arms.

Tinklepaugh and Hartman (p. 274) describe the sleeping behavior of the average infant macaque as follows:

> The babies, like human infants, devoted a good part of their early days to sleep. If the mothers were extremely weak, they lay stretched out on their sides, with their babies lying at their breasts. If they were stronger, the mothers slept in a sitting position and the babies supported themselves at the breast with their own hands and feet, either with or without aid of a mother's arm. The better-developed babies slept either with the recently discovered nipple in their mouths, or with their heads drooping slightly against the mothers' breasts.

During the early days Kras slept with all four extremities tightly clutching the cotton batting on which he lay. Later, however, when transferred to a cage containing a board shelf, he slept with the body bent forward, the legs flexed and drawn up under the body, and the arms extended outward and forward to form a cushion for the head.

Yawning was not observed (L. & W., no data; T. & H., 1 day). *Coughing* and *choking* were noted from the third day, especially after

TABLE 5

SENSORIMOTOR RESPONSES OF THE INFANT MACACA MULATTA MONKEY STATED IN TERMS OF THE DAYS OF THEIR APPEARANCE

Investigator	Sleeping	Yawning	Coughing, choking	Sneezing	Lid reflex, winking (non-visual)	Mouthing, biting, oral exploration	Sucking	Crying, vociferation	Scratch reflex	Righting reflex	Grasping reflex, clutching, clinging (non-visual)	Standing	Walking	Upward climbing on platform	Upward climbing on stick	Play	Use of cheek pouches
Foley	(3)	*	(3)	*	(3)	(3)	10	(3)	9	(3)	(3)	13	13	(3)	(3)	14	107
Lashley & Watson	1	*	*	1	1	1	1	1	11	*	1	12	12	*	*	15	61
Tinklepaugh & Hartman	1	1	1	1	1	1	‡	1	7- 14	1	1	†3 1 1	†5 1 1	†4 1 2	†3 2 1	14- 21	*

the too rapid ingestion of milk or orange juice (L. & W., no data; T. & H., 1 day). *Sneezing* was at no time observed, possibly because the animal was free from adequate stimuli, such as drafts, foreign particles in the air, or hair of the mother (L. & W., 1 day, T. & H., 1 day). We have stated above that the *lid reflex* or *winking response to a non-visual stimulus* was present from the third day (L. & W., 1 day, T. & H., 1 day)

Behavior which may be characterized as *mouthing, muzzling, biting,* and *oral exploration* was very commonly exhibited by our subject from the third day (L. & W., 1 day, T. & H., 1 day). During the first few days of observation Kras was continually pushing his face into the cotton batting on which he lay, and the mouth opened and closed periodically during this oral exploration. This mouthing reaction was undoubtedly present on the first day after birth, and was probably a response to tactile stimulation of the face, lips, inner mouth and gums. Tinklepaugh and Hartman (p. 267), after describing the infant macaque in nursing position on the ventral side of the mother, state that "its mouth, which has been constantly opening and closing, explores through the mother's fur and bites down upon any area or object which it can reach in this manner" and in this way finds the nipple.

This mouthing or biting response leads to the subsequent development of *sucking reactions,* which did not appear in the subject of the present investigation until the tenth day, at which time Kras sucked the finger of the experimenter (L. & W., 1 day; T. & H., exact time of appearance unknown). The writer is of the strong conviction that Lashley and Watson have erroneously assumed that since their subject nursed from the mother on the first day, sucking movements must have been present. This is obviously false, for we shall point out in the discussion of feeding behavior in the next section that sucking movements are a later acquisition, being developed as modifications of the original mouthing and biting responses.

Crying or *vociferation* was noted on the third day, the first day of observation (L. & W., 1 day, T. & H., 1 day), and was surely present at birth. Tinklepaugh and Hartman (p. 265) maintain that when the head of the typical monkey appears from the birth canal, "the eyes begin to blink and the baby gives shrill, piping sounds." The stimulus to and patterning of such behavior will be discussed in connection with the topic of emotional behavior in the following

section Mention might here be made of a recent cinematographic study by Gilmer (8) in which the following spontaneous responses of the newborn human infant were isolated and reported: crying, sneezing, clutching, mouthing, opening mouth, yawning, chewing, sucking, smiling, and other miscellaneous reactions such as isolated limb movements, rubbing the face, vomiting, hiccoughing, and frowning and wrinkling of the forehead Gilmer contends that the infant exhibits large patterns of reaction from which the individual responses must be isolated, and that classification, such as the above, is necessarily incomplete and selective

The *scratch reflex* or *scratching reaction* first appeared on the ninth day (L & W, 11 days, T & H, 7-14 days). The activity was poorly coordinated at first, and was largely restricted to the leg regions. By the fourteenth day, the scratching response had become perfected, and the infant macaque frequently scratched all parts of the body, including the head and chest Lashley and Watson (p 120) describe the first scratching reaction of their subject as follows: "The hind foot alone is used, scraping clumsily at his back and head The movements are slow and uncertain" They state that this reaction, established roughly during the second week, "became perfected by the fourth" Tinklepaugh and Hartman (p. 280) make the following comment: "Awkward attempts to scratch the head or shoulders with a hind foot appeared during the second week. This activity, though thought of as being entirely reflex in nature, was usually unsuccessful at first, and was not performed smoothly and with readiness until after numerous repetitions extending over 10 or 12 days" It is interesting to note that scratching activities in the present subject gradually diminished after the twentieth day, so that few of such reactions were noted subsequent to the fourth week.

Another elementary reaction, commonly exhibited by animals regardless of their phylogenetic status, is the *righting reflex* Kras exhibited this response on the third day, although it was unquestionably present at birth (L. & W, no data, T & H, 1 day) Figure 64, to be used below in another connection, shows the infant macaque in the middle of this pattern of behavior Note the partially extended legs, the arms extended over the head, the twisting of the neck and head to one side, and the marked extension of the toes. Although present at the earliest stages of development, this

reaction underwent marked improvement, with loss of useless and uncoordinated movements, and consequent reduction of time required to complete the righting response.

The *grasping reflex, clutching* or *clinging response* was exhibited by the subject on the third day and no doubt was markedly present at birth (L. & W., 1 day, T & H., 1 day) In fact Tinklepaugh and Hartman (p. 262, 285) report that this behavior is commonly present during the course of delivery, the infant reaching out with its arms as soon as they are disengaged from the birth canal and seizing hold of any objects in the immediate environment That adequate opportunity to "practice" such behavior commonly occurs in the average infant macaque is illustrated by the fact that in the undisturbed situation the mother usually sleeps in a sitting position while the baby supports itself at the breast with its own hands. The above investigators report (p. 274) that when the mother would climb down to the floor to secure food, the infant would often remove its mouth from the nipple and straighten out its arms and legs so that it hung "pendously" under the mother. It will be recalled that Cuvier (3) reported that the infant macaque, which did not leave the breast for 14 days, would release one nipple only to grasp the other. Similarly, the young rhesus described by Ram Bramha Sányál (23) clung to the breast for nearly one month Lastly, the reader will recall the testimony of Wallace (35) that his infant orang-outang frequently clutched his beard with enormous strength, or clung tightly to a stick or rag, as well as to the artificial "mother" which he constructed of buffalo skin

We can definitely state that one of the most outstanding and persistent behavior patterns exhibited by the present subject during the early stages of development was that of *contact-seeking* and the *seeking of bodily support* This finding substantiates the results of Tinklepaugh and Hartman, and proves without question that these reactions illustrate the most basic "drives" of the infant macaque Such behavior was elicited by any and all stimuli in immediate proximity to the subject, and involved tenacious *grasping, clutching,* and *clinging* reactions with all four extremities and seizing and biting upon the stimulus with the mouth In fact it was difficult to learn which of the four extremities, hands or feet, were more often and advantageously employed, although the advantage probably favored the former Kras acted positively to all objects within reach,

and there was no evidence whatsoever of any "instinctive" fear or dread of dangerous or otherwise obnoxious stimuli

This clutching reaction to various stimuli was undoubtedly an undifferentiated continuation of the clutching response present at birth It probably had its origin in prenatal life, the so-called "fetal movements," often visible during late pregnancy, being one such overt manifestation. The cotton batting and cellucotton, which covered the floor during the early weeks, were an excellent provocative of such clutching behavior, and the young animal would lie by the hour passively clinging to the cotton with all four extremities If the cotton were moved, the muscles showed increased tension, and the reaction became of an active rather than passive nature. Figures 1 and 2 show this behavior on the twenty-first day, whereas Figures 3 and 4 show Kras clutching on to a small piece of the cotton, his only "support," at the forty-seventh day. Figure 49, taken at the age of 106 days, pictures the monkey partially clinging to a towel suspended along the side of the housing cage. Figure 5 shows him clutching the supporting hands of the observer at 119 days of age, and in Figure 6 (same age) the edge of the table serves as a stimulus for the response. It is interesting to note that in the absence of external objects to which to cling, Kras would often frantically clutch parts of his own body, as can be seen from inspection of Figures 13, 14, 47, 48, and 85 It will be noted that by 247 days (Figures 7-9), the continuous clinging reactions had disappeared This transition was gradual, the active responses becoming more and more replaced by more passive and less intense responses, which finally disappeared except when the animal was emotionally excited. In fact, such clutching behavior was negatively correlated with locomotion. We have here dealt with so-called "normal" or usual clinging reactions. We shall have more to say below about certain abnormal responses, such as "fixations" and emotional behavior resulting from loss of objects to which to cling.

The strength of these grasping or clinging reactions is illustrated by the finding of Tinklepaugh and Hartman that one of their subjects on the third day supported itself and an 18-day old companion by clinging to the experimenter's finger by one flexed arm Kras, on the tenth day, maintained a hold on a horizontal wooden bar for a 10-minute period without signs of exhaustion According to the daily notes:

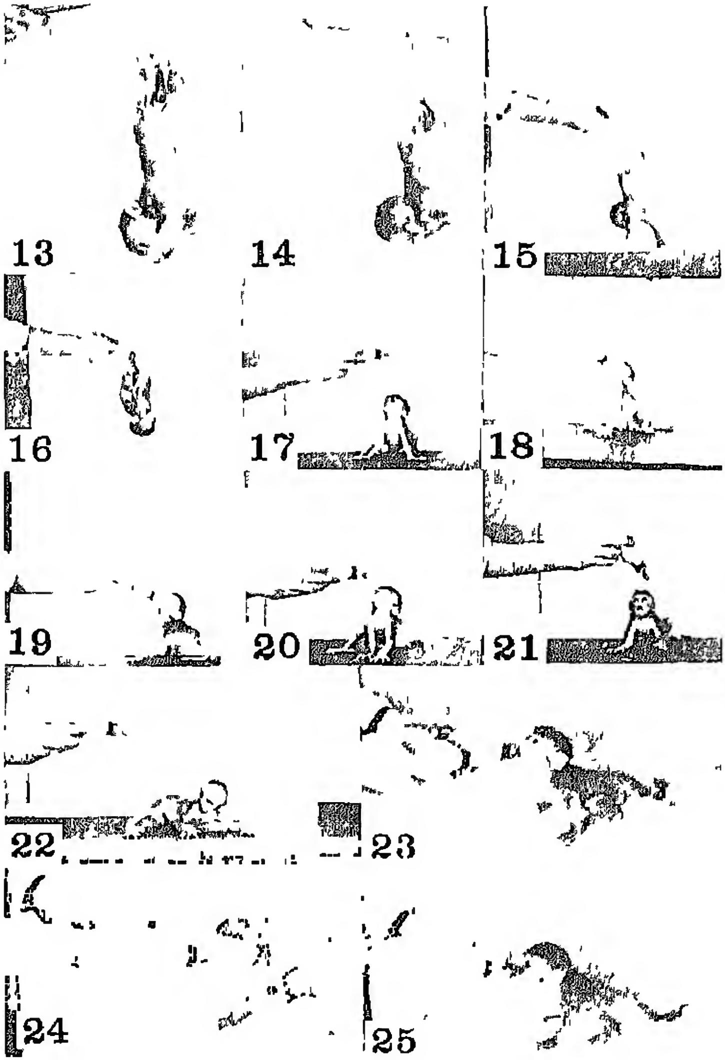

PLATE III

Figures	13-22	21 Days
Figures	23-25	47 Days

> He held entirely with the toes of the right foot, the right leg extended, and the left leg flexed and grasping to re-enforce the leg under strain. The arms and digits were at first extended, but failing to touch a means of support, they were drawn up, and clutched the face.

Figures 13-16 show the grasping reflex of the subject at the age of 21 days, the last figure showing the animal in the act of raising up so as to cling partially with the hands and arms instead of with the legs and feet alone. This was successfully accomplished only after approximately fourteen days of development.

The development of *locomotor ability* in the present subject seemed in large measure a function of the maturation or strengthening of the muscular and organismic mechanisms participating in the activity, the more strictly "psychological" factors, undoubtedly acquired, had little influence on the incidence of such behavior. For the first 6-8 days, Kras lay on the cotton batting with arms and legs spread out from the body in frog-like fashion, the digits and toes grasping the cotton. Figures 1 and 2, although taken at a later date, represent this posture, very well. From approximately the ninth to the twelfth days, the arms frequently became more flexed, and the legs were frequently drawn up under the body, so that the infant often appeared to be crouching (Figures 3 and 4). On the thirteenth day, *standing* was noted for the first time, the body being fully supported by the four extremities rather than resting at least in part on the cotton (L. & W., 12 days, T. & H., 3, 1, 1, days respectively). It will be noted that these results are more nearly in accord with those of Lashley and Watson than Tinklepaugh and Hartman, although neither of these studies has included statement of the actual criteria of standing employed. The latter investigators report (p. 279):

> When Joshua, the premature baby, was first placed upon the floor of the experiment room at the age of one day, his legs spread out in spider fashion and he was without sufficient strength to bear his own weight in a standing position. This is in contrast with the full-term baby Nina who . . . stood up unsupported within an hour of the time of birth.

Walking also appeared on the thirteenth day (L. & W., 12 days, T. & H., 5, 1, 1, days, respectively). Prior to this time the only actual locomotion shown by Kras consisted of grasping the cotton with the arms extended and pulling the body slightly forward. On the thirteenth day, however, actual walking occurred, the arms and

legs being alternately put forward and the body being supported entirely by this means. The first movements were feeble and poorly coordinated, and we concur with Tinklepaugh and Hartman in the statement (p. 278) that "the development of locomotor ability was slow and seemed to depend more upon increasing strength of the organism than upon practice." Lashley and Watson state that in their subject's first attempt to walk on the twelfth day, the movements were "badly executed and showed a decided lack of coordination," the first coordinated walking appearing during the third week

The perfected pattern of walking is shown in Figure 12, taken at the age of 365 days On repeated occasions after the first 3 months, Kras walked for short distances on the hind legs alone, and could easily stand up on two feet to take food (Figures 38-40). He never received tuition in this trait, however, as did the infant reared by Benson (cf Introduction).

Following the suggestion of Tinklepaugh and Hartman (pp. 278-279) the *tendency to climb or orient upward* was studied. This is interesting because of its biological adaptive value, since the young macaque climbs upward first to secure nourishment from its mother and since most monkeys in their natural, semi-arboreal existence take flight into trees when disturbed or frightened. The subject was released in contact with a vertically held stick and, on different occasions, placed upon a small wooden platform which could be inclined at various angles. Our major results are identical with the data obtained by those investigators. The *upward climbing reaction to the vertical stick* was present on the third day (L. & W , no data, T & H , 4, 1, 2 days, respectively), as was the *upward orientation on the elevated platform* (L. & W., no data; T. & H , 3, 2, 1 day, respectively). This reaction is not a simple one, however, as it is complicated by the grasping, clutching and contact-seeking reactions, as well as by emotional factors, to be discussed in the next section.

On the third and following days, when Kras was placed alone on the table, he immediately made a typical emotional response and backed away, legs, arms, and digits extended, and tail curled up over the back, as in Figures 51 and 52 (21 days). Upon reaching the inclined platform, he would turn and try to climb upward, as illustrated in Figures 53-55. This same behavior was exhibited with regard to a vertically held stick and platform held at various angles.

Of course the perfected upward-climbing response did not occur until Kras was sufficiently strong to accomplish it, although attempts and partial success occurred from the first day of observation This is in accord with the data of Tinklepaugh and Hartman, as was the finding that this upward climbing reaction tended to disappear after the infant had learned to walk and make a wider variety of responses with assurance

On the basis of the above data, Tinklepaugh and Hartman argue that this upward-climbing or orientation tendency is not a geotropism, dependent upon bilateral symmetry, but is due to differences in the development of the flexor and extensor muscles of the limbs. They continue (p. 279).

> Within two hours of birth, the premature baby, Joshua, could hang by one arm or leg, frequently flexed, for two or three minutes at a time In the same manner Nina held both herself and the 380-gram Joshua when she was but three days old The remarkable strength of the flexor muscles was demonstrated in these instances before Joshua was able to stand and before Nina could walk. It appears that the tendency of monkeys to climb upward is unlearned and furthermore that it is not tropistic in nature The latter assertion is justified only upon the basis of definition In our judgment the fact that a cat's claws are so constructed that it can climb up a tree more readily than it can descend does not justify us in regarding the cat as negatively geotropic In the same manner, we feel that the upward-climbing tendency of baby monkeys is due to non-uniform neuro muscular development and, therefore, is not evidence of negative geotropism

This interpretation is questionable on the basis of two observations made on the present subject. In the first place, locomotion in the backward direction, as described above, was very common during the earliest days This was accomplished through the use of the extensors as well as flexors, which would seem to demonstrate that the former were well developed at the time Secondly, if the infant were placed on the vertical stick or inclined platform with head facing downward, there was no resulting downward movement such as would be expected from the hypothesis of Tinklepaugh and Hartman, but rather the infant attempted to turn around and orient in the upward direction Thus the theory that such upward orientation is due to non-uniform neuromuscular development cannot be

accepted, nor can the writer offer any acceptable alternative The geotropistic theory merely begs the question. Rather would it seem at least a tentative guess that the response might be due to prenatal or early postnatal conditioning Since Kras remained with his mother for slightly over two days, we cannot say what his behavior in this respect might have been had he not originally climbed upward to receive nourishment or protection This reaction, even if accomplished with considerable trial and error, would be associated with feeding, protection, and means of support. This hypothesis, although undoubtedly an oversimplification, is offered merely as a suggestion, and could be tested by obtaining the infant immediately subsequent to parturition before any such behavior whatsoever had occurred.

Play behavior had its inception in random movements which first became frequent on the seventh or eighth day By the thirteenth day walking had appeared, and Kras made several excursions around the cage On the following day, active play was manifested (L. & W., 15 days, T & H, 14-21 days). These reactions, at first awkward and uncertain, became more and more synergic, finally culminating in frequently manifested and well coordinated play behavior These play activities consisted largely of *running, jumping, climbing,* and *leaping upon* and *seizing* objects, with attendant *vocalization* or contractions of the facial muscles in pursing the lips. During the fourth week, Lashley and Watson (p 136) observed that play in their subject "changed from simple pushing and grasping to the more complicated stalking and capturing of objects in the cage." At no time did Kras exhibit such behavior

Jumping was a relatively late acquisition, suddenly appearing during the fourteenth week. We quote from the laboratory notes for January 20th and 29th respectively:

> Kras climbed on top of his cage when the door was opened at 1 30 P M He danced around on all fours, pivoting on the front legs and swinging the hind quarters around, jumping up and down with the hind legs all the while We would frequently go backwards, reaching the end of the cage, after which he would stop and turn, only to continue the jumping or "bouncing" activities
>
> Today he saw a milk bottle on the floor, and he immediately climbed down from the cage to examine it He walked around on the floor, climbing between the rungs of a lab stool He then climbed up the chair and on to the lap of the E, from

which he jumped to the floor. He then climbed to the top of the stool and made a leap to a table approximately 3 feet away. His jumping appears to be well coordinated and under the keenest visual control.

This well coordinated play activity was the gradual result of a period less replete with perfected reactions. Like Tinklepaugh and Hartman, the writer frequently observed the infant's early attempts to reach and grasp objects well beyond his reach. Misjudged distances were the rule rather than the exception before complete coordination had been attained. This increased coordination was especially characteristic of *prehension* and *manipulation*. Among the early forms of such behavior was active manipulation of the nursing and teething nipple, during which times Kras would often seize the nipple and transfer it to the mouth. At a later date, the milk or food container served as a play stimulus, as did the wooden ball frequently left in the cage. The stimulus object was often carried around the cage, or lifted up on to the platform above. Whereas at first Kras had played only with objects given to him or in his immediate vicinity, he soon began to make excursions across the cage to obtain the object himself.

During the sixth month, Kras developed the habit of running around and around the cage in a circle, as does a caged circus animal. This reaction sequence did not last long, however, since it had practically completely disappeared within two weeks. During the tenth month, accompanying another increase in sporadic jumping activity, was the first appearance of the characteristic "swinging" behavior of the typical rhesus, in which the animal clings to the front grating of the cage and swings or shakes the body back and forth. Climbing reactions also increased during this period.

First *use of the cheek pouches* occurred at 107 days of age (L. & W., 61 days; T. & H., no data). This topic will be discussed in connection with feeding behavior in the following section. The reader is referred to Figures 30, 32, 33, 35, 36 and 37 for illustrations of such behavior.

From the above data, it is seen that the sensorimotor development of this infant macaque was rapid, although not quite so rapid as that reported by Lashley and Watson (19) and Tinklepaugh and Hartman (33). Whether this be an actual difference in dates of functional incidence or whether it be due to differences in methods of

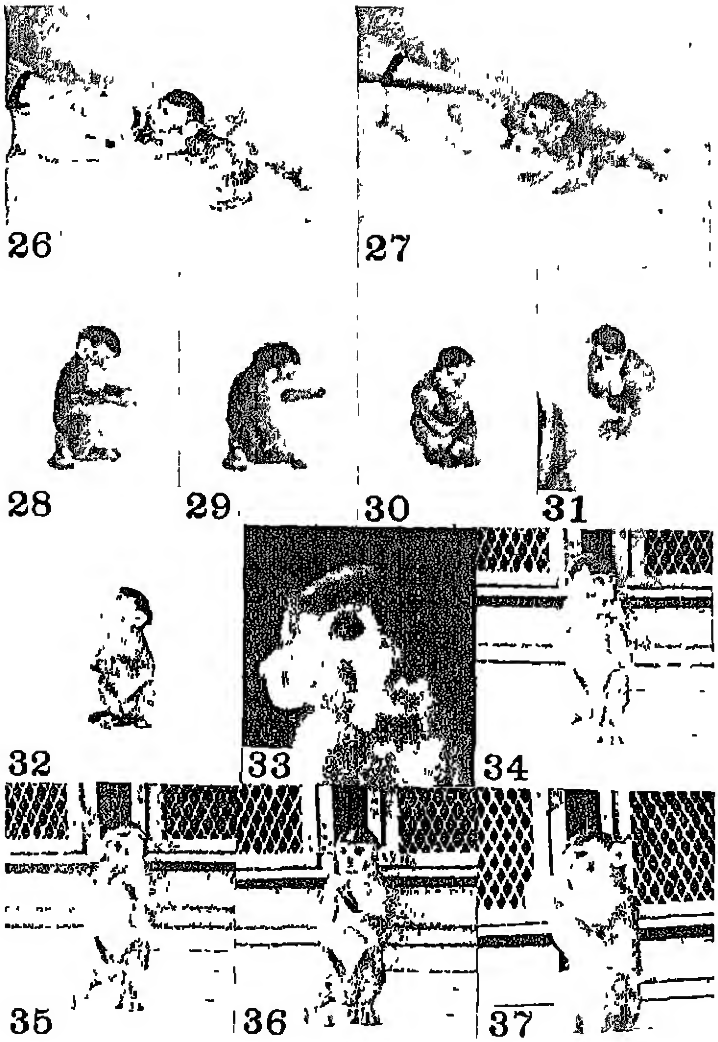

PLATE IV

Figures	26-27	47 Days
Figures	28-33	247 Days
Figures	34-37	365 Days

observation and criteria employed, cannot be said. The data of the former investigators might be questionable on some points due to their inability to observe the subject clearly, since the infant remained with its mother in the open yard. Likewise, the inability of Tinklepaugh and Hartman to keep their subjects under observation for an extended period made it impossible for them to see a given reaction in its entire perspective as well as to note the development of more complex activities. In general it is reasonably safe to conclude, however, that the sensory or receptor as well as the basic motor development of the infant *Macaca mulatta* is complete by the middle of the second week. Thus the sensorimotor coordination develops more slowly than is usually supposed, although more rapidly than in the human infant. These results in the sensorimotor and simple behavioral field bear out the conclusion of Schultz in the field of growth. After pointing out that the changes in the macaque are more rapid than those in the higher primates, particularly man, he states (cf. 10, p. 28): "The macaque, however, does not grow quite as rapidly as has been claimed by a number of authors."

3. *Complex Behavioral Development.* Let us first consider reactions associated with *feeding* behavior. Kras had nursed with the mother for the first two days after birth, prior to the beginning of the present investigation. The problem of dietary and feeding loomed large from the first. In the report of their observations, Lashley and Watson (19, p. 127) state with regard to their subject and his mother: "The forcing away of the young monkey and her increasing concern about him lead us to believe that this is about the time that weaning begins under natural conditions and at this age (seven weeks) he might easily be removed from the mother." Their subject was still nursing, however, at 15 weeks of age, at which time their observations ended. The present study shows, however, that the infant macaque can successfully be removed immediately after birth, perhaps, if the proper precautions are exercised.

From the third day, after isolation from the mother and other members of the species, Kras showed a tendency to bite at any object held within the visual field. This was possibly due to a number of factors, such as frequent exercise of the mouth with attendant biting movements (cf. 33, p. 272), lack of discrimination, and teething activities. For the first 2 months, the diet consisted exclusively of

diluted and sweetened milk and orange juice preparations, administered by means of a 4-ounce Pyrex nursing bottle with attached small size Santro nipple. The reader is referred to the section on Dietary for a detailed description of the changing diets employed

The nipple, however, soon became "differentiated" from other stimuli in eliciting the food-seeking response. Figures 17-19 show Kras endeavoring to reach the nipple on the twenty-first day. Note the extended digits on all four limbs, due to the absence of the usual cotton batting or other means of contact Also observe how the neck is stretched and the body raised by extension of the front limbs in order to reach the nipple. About the twenty-fourth day this behavior was replaced by frequent attempts to seize the nipple with the hands and transfer it to the mouth. Lashley and Watson (p 121) in this connection report that on the fifteenth day their infant "grasped Dolly's left nipple with his right hand and carried it to his mouth." This behavior accompanied increased eye-hand coordination and greater skill in manipulation. An example of such behavior, first observed during the eighth week, was that in which Kras would seize the nipple and lift it to the mouth and nose, then rise on the hind legs, become unbalanced, and lunge forward, lighting on all four legs.

When satiated, a definite negative or withdrawal response was made, involving expectoration of any additional food, rejection of the nipple, shaking of the head, withdrawal of the face and body, and repeated thrusting and slapping movements of the arms and hands. These last movements were very interesting and, although directed primarily at the nipple, often were so uncoordinated as to result in mere slapping of the floor or cotton If the nipple remained in the cage, it served both as a teething ring and as a play object, the play behavior consisting largely of oral and manual manipulation, as described in the preceding section.

If the nipple were removed before satiation had occurred, however, a violent emotional response would ensue, especially if the infant did not have the cotton or other object as a means of contact or "support." This behavior is progressively illustrated in Figures 20-22. Note the onset of the emotional reaction pattern as the nipple is removed, including puckering of the mouth and vociferation, in Figure 20, and the more violent stages pictured successively in Figures 21 and 22 Thumbsucking, to be discussed below, was

often exhibited on such occasions, the nipple being replaced by the great toe.

The development of sucking reactions, originally absent, has been described in the preceding section As there stated, *oral exploration, biting, mouthing* and *nuzzling* responses were commonly exhibited on the third day (L. & W., 1 day; T & H., 1 day), and were undoubtedly present from birth. The face and entire head were frequently pushed into the cotton in search of an object upon which to bite This reaction was at times a feeding response and at other times a teething reaction, involving tactile stimulation of the face, lips, inner mouth, and gums. Milk was first obtained by biting, chewing, and oral constriction of the nipple, with the resulting forcing of the milk out through the holes The *sucking* reaction evolved from this biting response, involving the use of a vacuum within the mouth and a gradual decrease of the biting component. As stated above, sucking was first definitely noted on the tenth day (L. & W., 1 day, T. & H., exact time of appearance unknown), although the biting component had not entirely disappeared until approximately the eighth week. Tinklepaugh and Hartman (33, p 282) make the following statement relative to the derivation of the sucking reaction as a modification of the biting response:

> There is reason to question the innateness of the suckling response in the monkey As we have shown, in our baby subjects the incisor teeth commonly erupted during the second or third week. We have described the incessant movements of their mouths during their waking hours If the finger of an observer was placed in the mouth of a baby, the subject usually bit down upon it repeatedly, with little or no evidence of sucking. The early responses of many of the babies to the nipple seemed to be of the same nature This indicated that tender or irritated gums were the stimulus for the initial mouthings of the breast We could not determine whether sucking behavior appeared automatically and full fledged, or whether swallowing and sucking responses were set off when milk was accidentally secured through the biting behavior

While in the act of feeding or nursing from the bottle, Kras made a repeated *grasping* reaction with the hands and fingers, involving alternate opening and closing of the hand and digits Although the cotton or arm of the experimenter was usually grasped on such occasions, these responses were continued if the infant and bottle, *in situ*,

were lifted into the air This behavior gradually diminished as the baby grew older, disappearing at approximately 10 weeks of age.

We have stated above that the infant soon learned to respond differentially to the nipple as opposed to other objects in the visual field, i e, he became positively conditioned to the nipple Further differentiation of response was slow to be accomplished. Thus when the baby was presented with two bottles with attached nipples, identical in every respect except that one contained milk and the other was empty, the one nearer to the subject was always chosen Figures 23-27 show such an experiment at 47 days of age. The nearer bottle is always chosen, and when the bottles are equally distant (Figures 26 and 27) the choices follow a chance order These reactions are examples of what Hollingworth has called "unsagacious behavior," since the animal, although making a redintegrative, conditioned or learned differential response to the nipple, nevertheless failed to take advantage of all the stimuli or cues afforded by the present context, viz, the content of the bottles.

The *cheek pouches* were not not used until 107 days of age (L. & W., 61 days, T & H, no data). This probably arose as the chance result of the displacement of solid food into the pouches, with resulting irritation, discomfort, or unusual stimulation Within a few days, however, use of the cheek pouches became relatively common, food being placed in the pouches on both sides, to be later poked out into the mouth cavity with the hands or shoulder blades It is quite obvious that this was a learned response. It would undoubtedly have occurred sooner had solid food been eaten at an earlier date, although it would possibly also have eventually resulted from an exclusively liquid diet. Isolation also probably contributed to the late incidence of such behavior, for had the infant been reared with others in a more competitive situation, there would have been more occasion for rapid eating as well as temporary "storing" of food

Food preferences were soon developed. The orange juice and milk preparations were eagerly taken at all times. An attempt was made during the seventh week to substitute already sweetened evaporated milk for that sweetened in the laboratory Kras immediately refused to drink any of the new preparation, which shows both a keen gustatory discrimination and a definite food preference The transition from exclusively liquid to liquid and solid food was purposely made as gradual as possible The cereals, introduced at the beginning of

the third month, were at first rejected, even in the form of gruel. The sugar content of the gruel was then increased, and after one or two times of practically forced feeding, this food was taken, after which the sugar content was gradually reduced

When the nursing bottle was replaced by a small pan or saucer during the nineteenth week, the drinking behavior was at first very awkward and ill adaptive. The milk was literally "eaten" from the pan. We quote from the laboratory notes for February 17.

> The mouth is placed in the milk for a few seconds, after which it is quickly withdrawn and rubbed against the side of the cage to remove the superfluous milk. . Kras slaps at the dish when his foot accidentally gets in the milk

Within two days, however, drinking activities became well coordinated and the mouth would remain in the liquid for relatively long periods of time. The use of the tongue was also soon developed, so that the face did not enter the liquid No difficulty whatsoever was encountered when cow's milk was used, beginning with the fifth month.

Solid food was first administered on the fifth month, if cereals are not included in this category. The wholewheat bread was fed first in the morning since at that time the infant was most hungry and would readily eat all of the bread, thereby insuring bulk in the diet. Banana was a favorite food from the first (eighth month), as were all kinds of fruit. The banana was never peeled by the subject. In fact no differential responses were made to the peeling and internal fruit This is significant in contrast to the frequent peeling of bananas by captive monkeys, even when the skin is to be eaten, and is certainly not to be attributed to lack of the requisite sensorimotor coordination. One other interesting feeding reaction was noted, and is illustrated in Figures 28-32. This was the frequent habit of biting off a small piece of food, taking it from the mouth and holding it out with one arm (Figure 29), and then reinserting it into the mouth Figures 17-22 show the nursing reactions at 21 days of age, while Figures 23-27 picture such behavior at the age of 47 days. Feeding responses to solid food (banana) are shown at 247 days in Figures 28-33 and at 365 days in Figures 34-37. Figures 38 and 39 picture the subject reaching for a banana at 247 days of age, and the same reaction at 365 days is illustrated in Figure 40

No coprophagous behavior was noted at any time. On a few oc-

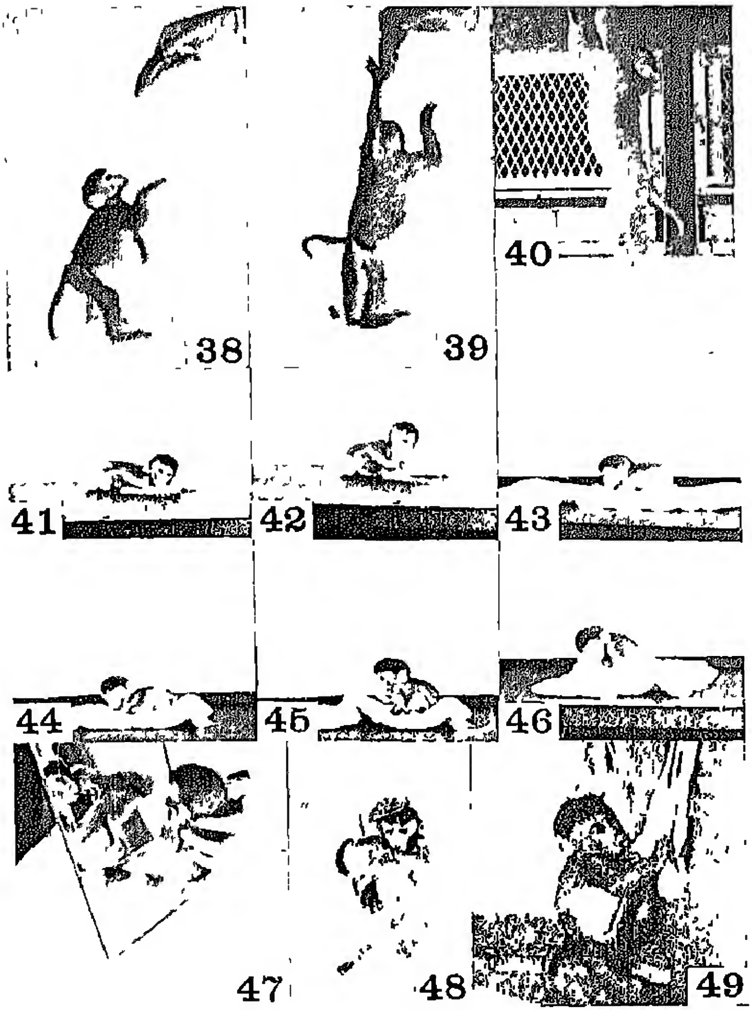

PLATE V

FIGURES	38-39	247	DAYS
FIGURE	40	365	DAYS
FIGURES	41-46	21	DAYS
FIGURES	47-48	47	DAYS
FIGURE	49	106	DAYS

casions the infant examined or smelled the feces, although there was never any semblance of their being tasted or eaten

Vocalization was less frequent than in the typical macaque of the same age. The repertoire was practically complete by the thirteenth week. Lashley and Watson (19, p 129) state that in their subject by the ninth week "all of the vocal sounds of the adult have been heard with the exception of the ones which are used in the exercise of the sexual function They are in a high falsetto key" In general, the following three types of cries may roughly be distinguished

(1) *"Play cry,"* consisting of a clear, shrill, and high-pitched cry made with the lips pursed and rounded A given cry increased and then decreased in pitch. See Figures 20, 59, 90

(2) *"Fear-Pain cry,"* consisting of a scream of rapidly varying pitches, made with the mouth open and the entire face wrinkled and distorted See Figures 21, 22, 50, 51, 52, 58, 60, 64

(3) *"Food-Contentment cry,"* consisting of a soft, short, gutteral, and slightly hoarse noise, often accompanying eating, gentle stroking or handling, or attainment of contact or support, and often associated with rapid opening and closing of the lips See Figures 23, 82

It is obviously difficult to reduce the complex vocal behavior of the *Macaca mulatta* to a simple classification The above seemed to the writer best to represent the typical cries made by the infant during the various periods of observation and study Other cries could conveniently be considered as modifications of the above three.

The development of *prehension, manipulation,* and *eye-hand coordination* has been discussed at some length in the preceding section, and need not be repeated here A word may be added on *handedness* On repeated occasions throughout the year, records were taken of the number of times each hand was used in reaching for food The data show that the infant was ambidextrous If the food stimulus was presented to one side, the hand on that side was favored and more often employed, whereas if the stimulus was presented directly in the median line of the subject, each hand was used approximately 50% of the time These data were roughly corroborated when the amount of time each hand was actively employed in gross play behavior was taken as the index or criterion. The reader is also referred to the preceding section for a discussion of *play behavior*

Let us now consider the *emotional behavior* exhibited by the infant subject during the various stages of development, as well as a few of what may be classed as *"abnormal" reactions* The emotional responses themselves are abnormal in that they deviate from the individual's behavioral norm, whereas some of the other responses to be mentioned deviate from the group or species norm, the behavior of the typical macaque It is hoped that material of this kind will eventually lead to a more inclusive abnormal psychology, wherein "abnormal" behavior will be that deviating from the norm of a given species Such a broad comparative approach will not only do much to clarify problems and concepts already existing and unsolved, but will give the entire subject a more stable basis and a more inclusive horizon, thereby opening up vast fields for research and scientific formulation

It will be recalled that Watson (37, 38), in his classic experiments on the emotional behavior of newborn human infants, found three fundamental patterns of reaction, which he termed *fear, rage* or *anger,* and *love.* He further stated that "they are far more easily observable in animals than in infants" Most reaction tendencies at this age, however, were positive, for Watson states (38, p. 270) that "once the reaching coordination has been formed, infants respond positively to nearly all small objects which are given a high stimulating value by moving them" A brief description of each of these emotional reaction patterns follows:

> (1) The stimuli for *"fear"* were loud sounds and the removal of support, and the reaction pattern of the infant involved sudden catching of the breath, random clutching with the hands, sudden closing of the eye-lids, puckering of the lips, crying, and possible flight
>
> (2) The stimulus for *"rage"* or *"anger"* was hampering of the infant's movements, and the behavior pattern consisted of crying and screaming, stiffening of the body, slashing or striking movements of the hands and arms, drawing up and down of the feet, and holding of the breath.
>
> (3) The stimuli for *"love"* included stroking or manipulation of erogenous zones, tickling, shaking, gentle rocking, patting, and turning the infant over on its stomach, and the pattern of response involved cessation of crying, smiling, gurgling and cooing, and extension of the arms

In general, the results of Watson for the human infant are roughly

identical with those for the infant *Macaca mulatta* with the single exception that loud sounds did not elicit any emotional response whatsoever in the infant macaque, although such a response was very intense to stimulation by removal of contact or support Let us very briefly review the emotional repertoire of the present subject We have previously presented material showing, as did Watson for the human infant, that the stimuli eliciting negative reactions were relatively few, whereas the bulk of the behavior, especially during the earlier periods, consisted in clinging, clutching, grasping, oral examination, biting, and later sucking reactions to almost every stimulus, regardless of its possible dangerous or injurious nature Thus, for example, Kras immediately placed his finger in a gas flame at the age of 3 days, although only one trial was needed to form the opposite association. We shall describe below the positive clinging behavior of the present subject in response to various laboratory animals, as well as similar behavior in response to a snake on the part of the subjects of Tinklepaugh and Hartman. Let us briefly consider each of the emotional reactions elicited experimentally on the third day, together with their corresponding stimuli.

The *"fear reaction,"* at 3 days of age, was readily elicited by the removal of bodily support, as Watson found, or by mere removal of contact There was no reaction other than the pinna response (see previous section) to intense auditory stimuli, such as a sharp whistle, the sound of a buzzer, the striking of a steel bar, and the notes of a clarinet, nor was there an emotional response to the visual presentation of various laboratory animals and other miscellaneous objects The behavior pattern was practically identical with that described by Watson, and stated above. The clutching element was very pronounced, and the "fear-pain cry" was frequently uttered. Swaying movements, with the hands clutching the floor or hind legs, were also noted, and thumbsucking was relatively common. Plate VI, Figures 50-64, shows such a reaction pattern elicited by loss of contact, the stimulus having been the removal of the cotton batting on which the animal lay Note the extended digits, the facial contortion, the backward movements, and the almost complete cessation of such activities when the platform is reached. Figures 50-58 illustrate such reactions at 21 days of age, whereas Figures 59-64 were taken at the age of 47 days. This behavior was very common until locomotion was well developed, although it occasionally occurred subsequent to this time, as will be pointed out below

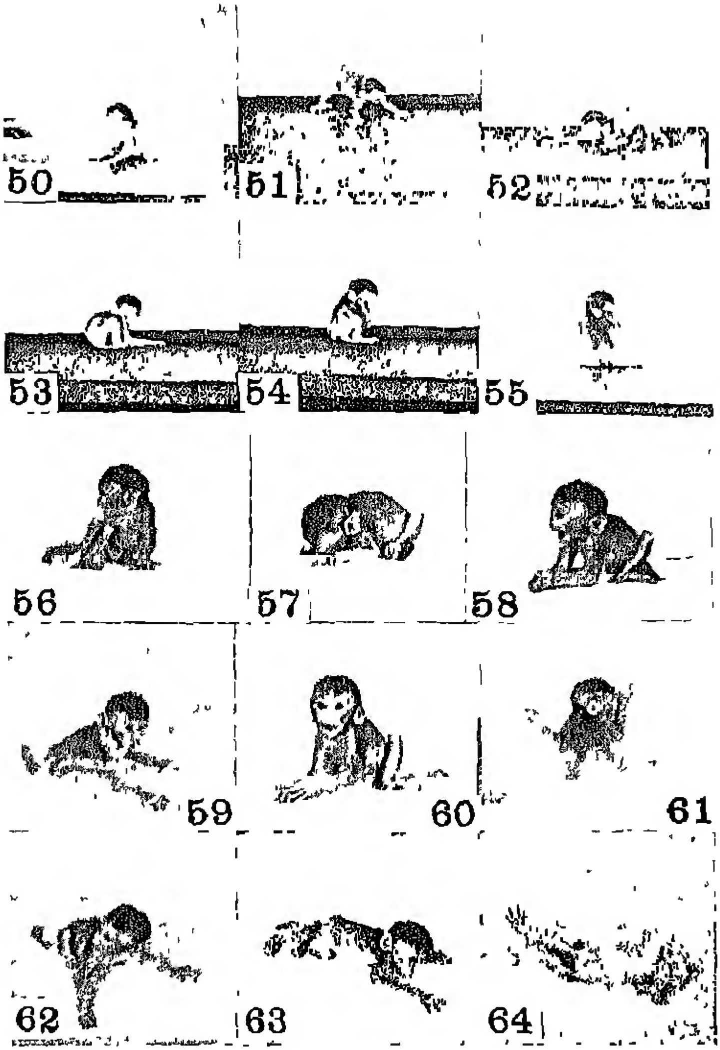

PLATE VI

FIGURES	50-58	21	DAYS
FIGURES	59-64	47	DAYS

The *"rage"* or *"anger reaction,"* described by Watson, was also exhibited by the infant macaque at the age of 3 days, although it was relatively mild in comparison with the intense "fear" response. The stimulus was provided by hampering or restraining the animal's movements, and the behavior pattern consisted of stiffening of the body, striking movements of the hands, arms, and feet, holding of the breath, and screaming. This vocalization, however, was very similar to that in the "fear" reaction, being what we have called the "fear-pain cry."

The *"love reaction,"* a positive emotional response, was also exhibited from the third day, and conformed rather well to Watson's description. Especially when contact or support was gained did this behavior occur, at which time gentle stroking and patting of the infant served to heighten the reaction. At such times the "food-contentment cry" was made.

Tinklepaugh and Hartman also subjected their three infants to various auditory and visual stimuli, with the same general results. They found that "so long as a subject was clinging to some object with both hands and feet these stimuli aroused no emotional responses." They continue (33, p. 281):

> In the course of our work with them, however, we found that as soon as a subject was prevented from making its grasping, contact reaction, it cried and struggled in a manner indicating fear. If, on the other hand, it was thwarted in its movements by either the observers or its mother, it responded by quick bodily jerks which were probably indicative of either anger or rage.

They state that the failure of the subjects under two weeks of age to respond to loud sounds may have been due to incomplete development of the auditory apparatus. This is quite possible but highly improbable, since a negative emotional reaction to intense auditory stimulation was not manifested by the present subject after the auditory function had developed to the fullest extent. Tinklepaugh and Hartman conclude that "inhibition of contact-making reactions for the monkey babies was comparable to removal of support for Watson's human baby subjects. Our data indicate that the initial emotional responses of monkey babies are similar to those of human babies both in their nature and in the stimuli which evoke them."

Since their work was purely observational and involved no experi-

mental control over the stimulus situation, Lashley and Watson (19) have little to report regarding their subject's emotional behavior On one occasion, during the eighth week, the infant was endeavoring to obtain some choice food then in the possession of the mother They state (p 127).

> This led to severe and continued chastisement She first pulled him away, holding him on level with her eye, and looking fiercely at him all the while Then cuffed him with the paw, and bit him upon the skin of the head and back. The young monkey was forced to keep out of her reach He became very angry, chattered and hopped up and down in one place, which seems to be the simian infantile way of expressing anger.

It will be recalled that the housing conditions of the subject were varied from time to time during the course of development Each change usually resulted in a series of intense emotional reactions, although readjustment usually occurred within a few hours at the most The exact dates and detailed description of such changes are given above in the section on habitat, and need not be repeated here When transferred from cotton batting to sawdust, even though remaining in the same cage, Kras showed a slight emotional disturbance, clutching at the sawdust in much the same way as he had done to the cotton. If placed on the bare wooden board at the rear of the cage, however, he made a violent "fear" reaction until he reached the sawdust Adaptation was rapid, for within 15 minutes he had crawled up onto the board of his own accord, this reaction illustrating the pronounced random activity and exploratory behavior. Thumbsucking was very commonly observed at this time When a grill and regulation board shelf were later inserted into the housing cage, another and even more violent emotional disturbance ensued Loud and numerous "fear-pain cries" were uttered, and the infant remained on the shelf, huddled into a corner. Swaying movements and thumbsucking were observed. For the remainder of the day Kras would not touch the floor grill. He would jump from the board shelf directly on to the grating of the cage door, or would climb around via metal fluting on the side of the cage. Normal adaptation had occurred, however, by the following day A final emotional upset of this type resulted when the infant macaque was transferred to the large monkey cage in an isolated part of the primate quarters, although normal play behavior was observed within

3-4 hours The above are examples of *emotional behavior resulting from novel and unfamilar situations in which the stimuli previously serving a contact or "support" function were absent,* and adaptation occurred only when other stimulus objects had acquired such instigative functions.

We have pointed out above that if the positive clinging response, continuously present during the early days, was thwarted or disturbed, a violent emotional state was produced. If the infant was left alone on the cotton, however, he would at times subsequently leave the cotton and come to the front of the cage for food. This behavior led to an interesting observation on November 30, at the age of 53 days We quote from the laboratory notes for that day.

> The nursing bottle was held just within the door of the cage Kras eyed it intently, and made incipient movements toward it but retained his hold on the cotton on which he lay. He made repeated trials, each time progressing a little nearer to the nipple, but each time hesitating and then dashing back to the cotton Finally he reached the nipple, but when it was later suddenly removed, a violent emotional reaction ensued, and he ran back to the cotton Nor would he approach the nipple on immediately succeeding presentations

Thus there was a "conflict" between the positive response to the cotton batting and the positive response to the nipple and nursing bottle. A temporary adjustment could be reached favoring the food stimulus, although when the situation was disturbed or when the food stimulus disappeared, the infant reverted to the stronger S-R system. Below is an example of similar emotional behavior when the cotton or contact stimulus was removed. Note that the nursing bottle then ceases to function as a nutritive stimulus but acquires a contact function This is reported in the notes for December 11.

> Today the subject was placed on a large table and allowed to cling to the arm of the experimenter This is a common procedure. The milk bottle was then presented some distance away, just out of the infant's grasp. He was hungry and reached for the bottle. Unable to get it, he started to loosen his hold on the arm and go to it. He looked around and "squealed" violently and renewed his grip. This was repeated several times, each time the animal drawing nearer to the bottle and withdrawing farther from the arm. Suddenly, the experimenter quietly withdrew his arm, and the subject at once made a loud cry ("fear-pain") and lunged at the bottle,

> clutching it with all four limbs He did not drink from the bottle for 2 to 3 hours.

Similar behavior was noted when the subject was placed with a rabbit, to which he clung tightly The rabbit hopped rapidly and the infant, losing his hold, would rush to the experimenter's legs for support. If the rabbit was closer, however, its potency as a contact stimulus was great enough to inhibit the other conflicting response, and he would dash after the rabbit.

Clinging behavior was frequently elicited by the experimenter's hand, so that it literally became a *fetish* for the animal, although without any sexual significance whatever, and he would rush and cling to it whenever the cage door was opened The following quotation from the laboratory notes for January 29 illustrates a very common clinging response to the experimenter's legs and feet:

> Kras played on the floor, running under tables and stools, and jumping and climbing from one to another As the experimenter started to walk out of the room, the infant made a flying leap at his legs, missed his aim, and shrieked loudly To see what would happen, the investigator ran out of the room Kras followed, running always "under cover," stopping to cling to legs of chairs, tables, refrigerator, etc. He followed the investigator through three rooms and at last caught up with him and clung tightly to his leg, making his typical "mouthing" reaction, consisting of a rapid opening and closing of the lips The "food-contentment cry" was also uttered.

This behavior was so frequent that it grew troublesome, and on March 19, the animal was lifted up with the foot and "thrown" across the floor. This served as an adequate reconditioning stimulus, for he would afterwards follow the investigator through the laboratory, but would not cling to his legs and feet.

The fits of emotional behavior exhibited by the subject were sometimes very similar to the *tantrums* of the human infant If a play or food object was taken from him, he would often exhibit such behavior, which in general appearance was similar to that pictured in Figure 64. Another interesting type of behavior was his "objection" or *negative reaction to the change factor,* although this never matched the "fear" or "rage" responses in intensity The laboratory notes for December 10, for example, describe an instance in which, after lying quietly in his cage, the infant objected to being picked up, only subsequently to object to being put down The negative be-

havior here seems to be in response to the change factor, although the loss of support is undoubtedly of major importance. On May 17, when a small leather belt with chain attached was fastened about his waist (as in the case of other laboratory animals), Kras showed the characteristic emotional grasping behavior, clutching himself, swaying or oscillating back and forth, sucking his thumb, and crying, until the belt was removed

An additional remark might be made in regard to some of these emotional and often "neurotic" symptoms The *oscillating* or *swaying movements*, frequently mentioned above, were present from the third day, and were continued, on proper occasion, throughout the year. These were usually made in an emergency and highly emotional situation The hands and arms were either placed on the floor directly in front of the body, as in Figure 58, or grasped the thighs or hind legs, the total body maintaining a sitting posture. Rapid and rhythmic swaying movements were then made, the body being alternately raised and lowered Nissen has unpublished observation of the occurrence of such behavior in the chimpanzee, and similar reactions were exhibited by the isolated infant macaque of Engle (cf Introduction).

The so-called *"mouthing response,"* similar to that of the typical rhesus monkey, was noted for the first time on December 19, at 71 days of age. This response was relatively rare, however, although it was sometimes made before or after feeding, or when the infant had achieved contact or support after having been frightened or otherwise emotionally stimulated If the investigator gently stroked and "talked" to the animal at such times, the response seemed to be facilitated and prolonged Kras also made this reaction to his mirror image during the later weeks, as will be pointed out below. The behavior pattern involved rapid opening and closing of the lips, and often occurred in conjunction with the "food-contentment cry" Such a reaction is often mimicked by animal dealers to gain the confidence (rapport) of an animal.

Thumbsucking, another emotional accompaniment, was first noted on the tenth day The nipple of the nursing bottle was sometimes replaced by the thumb, and at other times the thumb was sucked when no food had been recently presented. Thus no one cause can be given for this mannerism, and it was possibly the result of a number of complicating factors. Such behavior might at times have

been due to teething activities, at other times it might have been a food substitute, on other occasions an emotional outlet, and in further cases a mere habit. This behavior at times seemed to occur in waves, although there was hardly a day when a minimum of such activity was not observed. It is quite probable that all of the above factors were causally involved at least during some period, for no one alone would account for the particular variety of occasions in which the behavior occurred The great toe of the hind foot was usually sucked, the reaction favoring the right foot during the early days, and changing to the left at approximately 87 days of age. Frequently the reaction was so persistent that the infant would walk around the cage on three legs, with the great toe of the fourth sticking in his mouth Figures 41-46 show thumbsucking at 21 days of age, whereas Figure 47 shows this reaction, reflected in a mirror, at 47 days. Figure 48 pictures the infant grasping his own hands and arms to secure contact, and Figure 49 illustrates the sucking response at 106 days of age, the infant at the same time clinging to a towel suspended from the side of the cage.

Lastly, we may mention examples of behavior not unlike that classed as *"habit residuals"* in the abnormal human subject On a few occasions, during the periods of reduced thumbsucking, the infant was observed to begin the upward motion of the hind foot as if to place the great toe in the mouth, and then to cease before the behavior segment was completed Another possible example of similar behavior was the repeated grasping movements of the infant, made while nursing from the bottle These were possibly remnants of the clinging behavior so essential to maintenance of the correct orientation and posture with respect to the teat of the mother during the first 2 to 3 days

As would be expected from other studies on isolated animals, the sexual behavior of the present subject was practically nil The swaying movements and mouthing reactions, although superficially resembling modifications of sexual behavior, had no such actual significance The testes did not descend during the first year (see section on physical development), nor was erection observed during this period, although it has been subsequently noted In striking contrast, Lashley and Watson (19, p 130) observed such a reaction on the sixty-first day. They state:

> Mother had fed and had carried baby to the shelf. He was restless and danced about trying to get down She tried to nurse him three or four times but he always struggled to free himself Finally she held on tightly to him and began to pick him around the sex organs Erection appeared. The mother continued to pull at the organ and to push back fore-skin Baby became very quiet and began to nurse, pulling at the short rope attached to her collar with one hand and reaching back to play with his own sexual organs I have seen the mother pick over his sexual organs often before but this never before produced an erection

Let us now consider the *reactions of the subject to other animals.* In general, we may state that all animals, regardless of species or physical or behavioral characteristics, elicited a positive approaching and clutching reaction if Kras and the animal were placed alone in the same vicinity. Figures 65-72 show such a response to the albino rat at the age of 21 days. Kras clutched violently on to the animal, and in Figure 69 his body has entirely concealed the rat from view. When the rat ran oft of the table, Kras followed and caught it, as shown in Figures 71 and 72. The same positive behavior with reference to the rat is illustrated at 365 days in Figures 73-75, although the clutching component of the reaction is less intense, the rat serving more as a play stimulus. Figures 76-78 picture this behavior at 47 days of age in response to a guinea pig. On such occasions Kras would cling to the animal if either he or the animal were lifted from the floor. Similar positive behavior was observed in response to the cockroach and rabbit At 47 days, Kras would examine the cockroach intently with his fingers and nose; and the rabbit, at 151 days, was "ridden" all over the room. Tinklepaugh and Hartman (33, p. 281) report the placing of a live garter snake in the paddock with two of their subjects and their mothers They state.

> To our surprise neither the mothers nor the babies demonstrated fear of the reptile The mothers followed it about the cage and only when it moved quickly after being touched by one of them did they withdraw from it in any manner The babies, which were at that time between a month and six weeks old, were interested in the snake and had they not been restrained by their mothers would have stepped on or seized hold of it.

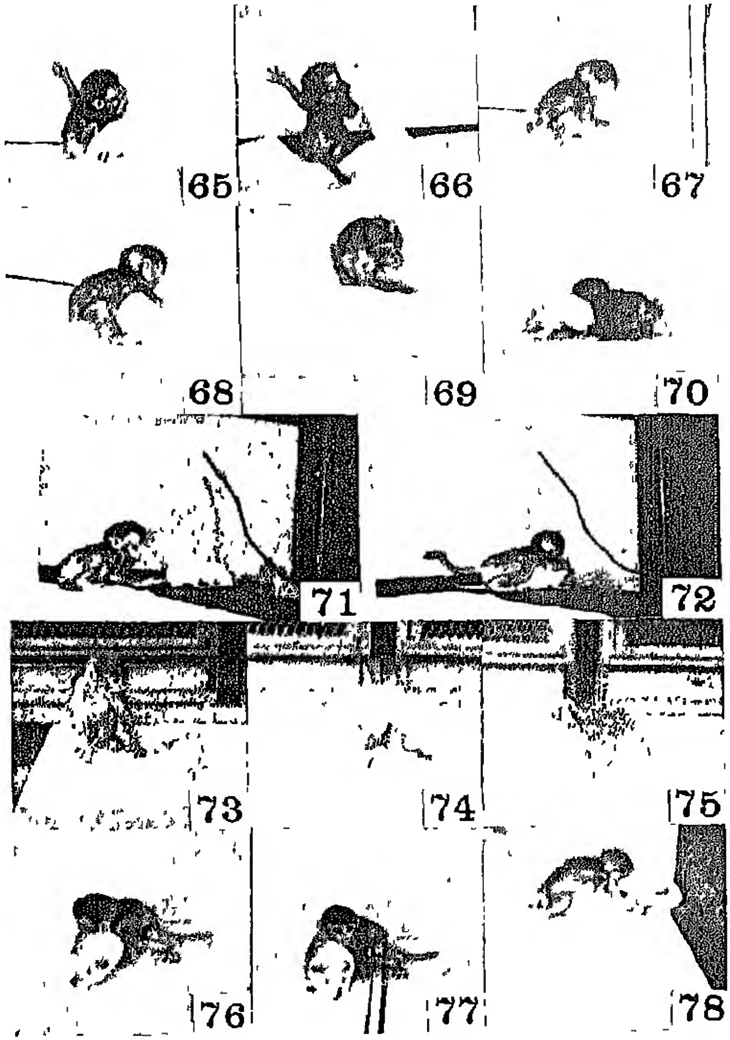

PLATE VII

Figures	65-72	21	Days
Figures	73-75	365	Days
Figures	76-78	47	Days

At 47 days of age, Kras was placed with a toy monkey, as illustrated in Figures 79-84 He again showed the characteristic clutching behavior On January 3, at the age of 86 days, when placed for 5 minutes with each of three laboratory monkeys of the same species, similar behavior ensued Two of the larger monkeys, one male and one female, paid little attention to the infant as he clutched to their hair, although one female presented her ventral side to the infant and evidently derived satisfaction from his clinging closely to her. On February 15, when 129 days old, Kras was presented to Meshie, a tame and house-broken female chimpanzee belonging to H C Raven, of the American Museum of Natural History The chimpanzee had not seen a monkey since January, 1931 We quote from the notes

> At first Kras would not let go of the investigator's hand, and then kept continually running back after having been pulled away and put with the chimp. Finally, Meshie picked him up, and he clutched tightly on to her arm She traversed the twelve-foot table, holding him with both arms, and then sat down on a box Finally Kras managed to free himself, and he ran away, leaping 4 feet off of the table and on to the floor, the chimpanzee following in full pursuit

Tinklepaugh and Hartman (33, p 272) mention the case of a rat "adopted" by a rhesus monkey Their description merits full report

> The relation of the baby monkey to its mother is somewhat paralleled by that of an albino rat to the monkey Psyche who "adopted" it At the time of this incident Psyche was kept at the Psychological Laboratory of the University of California She was without other companions and for that reason a young male rat was placed in the cage with her The two animals soon formed an attachment which persisted until the rat's death several months later Psyche carried the rat with her in the laboratory and at times out onto the university grounds She picked through its fur, protected it from attack, and, in general, behaved toward it as a monkey mother does towards her young, even to the point of resenting its eating The rat, in turn, was dependent upon the monkey and would follow her about or or run to her for protection The position of the rat in the monkey's arms, when it was being held or carried, was not determined by the monkey She would seize and draw it to her breast The rat would struggle until it achieved an upright position, but the relation of its ventral or dorsal side to the

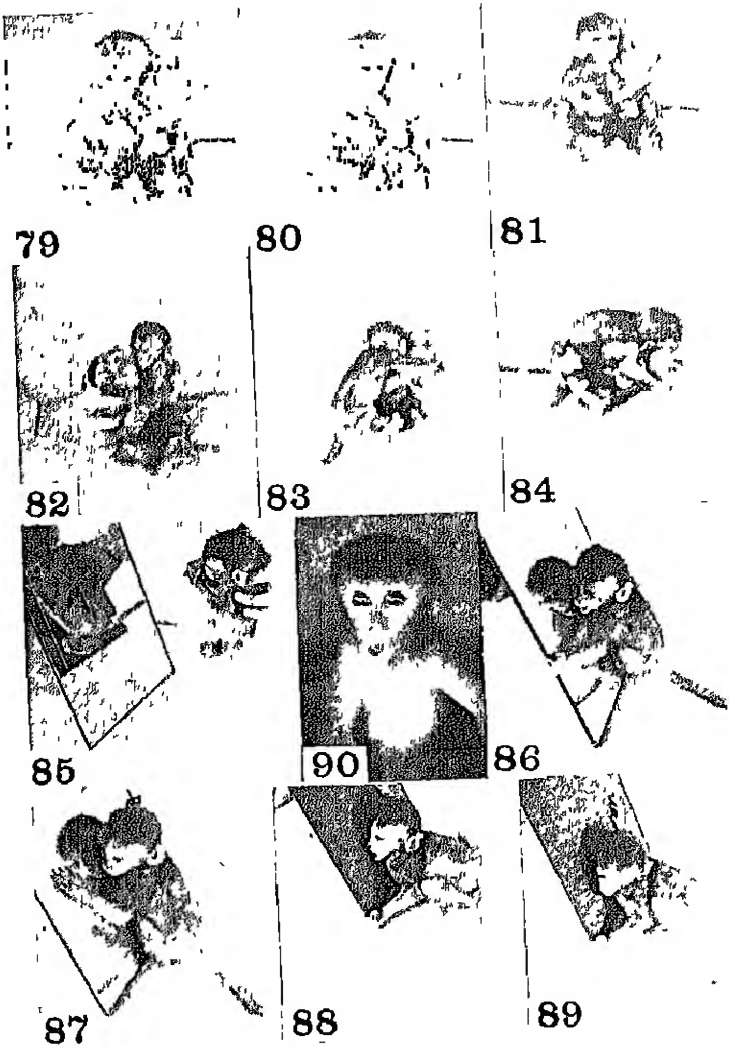

PLATE VIII

FIGURES	79-89	47 DAYS
FIGURE	90	106 DAYS

> monkey's breast was purely a matter of chance Had the rat been dependent upon the monkey's breast for nourishment, due to its inability to clasp the host and thereby turn towards the breast, it undoubtedly would have starved In other words, the rat, for purely structural reasons, was in the helpless position of the premature monkey baby who because of weakness cannot orient itself toward the mother's breast

The *reaction of the present subject to his mirror image* was also investigated At first there was no apparent reaction to such an image, for the behavior was the same in regard to the front and back sides of the mirror The mirror, at this period, seemed to be no different from any other stimulus object, merely eliciting the usual clinging reactions This behavior, at 47 days of age, is illustrated in Figures 85-89. At 117 days of age, however, a differential response was noted. The mirror was presented with the animal contentedly clinging to the experimenter's arm. Upon seeing his image in the mirror, Kras made the "mouthing" response, kicked with all four legs, then cried loudly ("fear-pain cry"), and defecated On subsequent presentations, the emotional element disappeared, although the "mouthing" behavior continued in exaggerated form

Lastly, let us consider the general topic of *grooming*. Yerkes (42, p 4) has defined grooming as "a pattern of social behavior whose essential features are visual examination, search and manipulation of the skin and hair of a companion with fingers and lips, removal of dirt, dandruff, scabs, parasites, and other extraneous materials, and their conveyance to the mouth of the groomer, whose lips, tongue, and jaws meanwhile may have been in motion, with sound production, as if in anticipation of something to be swallowed. Commonly swallowing ensues, if the object is not disagreeable" Kohler (17), for example, includes such behavior as flea-picking, hair-dressing, skin-treatment, and toilet-making It should be pointed out at the start that Yerkes, although he recognizes the phenomenon of *auto-grooming*, exhibited by many vertebrates, nevertheless uses the terms "grooming" consistently to designate "social" or inter-individual behavior of the given type Since the subject of the present investigation was reared in isolation, no material on this particular aspect of the topic is available, although "auto-grooming" could easily be studied.

Grooming has often been held to be of tremendous importance from the *phylogenetic* point of view Watson (36, p 178), with

reference to the *Macacus rhesus*, says that "flea-catching, regardless of what the sociologists may have to say, is the most fundamental and basal form of social intercourse between rhesus monkeys" Zuckerman (43) points out that for the baboon also grooming is of fundamental importance. Thus the phylogenetic evolution and development of such reactions may be traced, culminating in the so-called "delousing" behavior of early man, which anthropologists (cf Malinowski, 21, p. 327) have long regarded as a widespread cultural phenomenon in primitive life In fact Yerkes (41, p 12) has gone so far as to state that " 'flea-picking' in the monkey, 'grooming' in the chimpanzee, and 'delousing' in man, are functionally identical patterns of response" In summary form, his hypothesis (p. 21) is that "grooming in the chimpanzee, as type, represents a genetically important pattern of primate social response, from which have evolved incomparably useful forms of social service, that it represents a step in the socialization of primate behavior and stands as forerunner of human hair and skin dressing, nursing, medical and surgical treatment"

Let us now consider the *ontogeny* or development of grooming behavior in the individual animal On the basis of the above quotation from Watson, Yerkes concludes that Watson evidently considers such acts to be instinctive. As to his own opinion, Yerkes (41, p. 113) states

> So far as I have been able to learn, no one at present knows whether in the howler, capuchin, macaque, baboon, or other monkeys the activity is primarily inherited or individually acquired Initial attempts in the Yale Laboratories of Comparative Psychobiology to observe the first appearance and development of grooming in chimpanzees indicate, seemingly, that it may appear in a chimpanzee infant which has been reared from birth in isolation from its kind and on which social tradition and parental tuition cannot have operated

The relevant data upon which Yerkes bases this statement are those of Jacobsen, Jacobsen, and Yoshioka (14, p 75) on the development of social play in their chimpanzee subject by the thirty-ninth week. They state·

> The second pattern of social play, or perhaps better, manipulation with social import, is related to the previously mentioned interest in exploring the details of the face, hands, and

> arms of the infant's human companions. The *characteristic* chimpanzee pattern of skin dressing, in contrast to the earlier simple exploration, appeared quite suddenly when the infant saw a scab on the back of the attendant's hand She rushed across the cage, walking erectly, arms extended in advance of the body, and then thrust the index fingers of each hand through the wire-mesh so as to bring them together on the scab which she then pinched and prodded Erection of the hair and *smacking of lips and tongue accompanied* the manipulation Later the lips and tongue were used for examination of the scab. The complete pattern of behavior was strikingly similar to that of the adult chimpanzee, and occurred before this animal had had experience with creatures of its kind

Yerkes maintains that "Jacobsen's observation justifies the wholly tentative statement that in the chimpanzee, at least, grooming may be structurally conditioned, even if to a considerable extent modified subsequently by experience"

With reference to the chimpanzee, Yerkes also states (p. 14) that "during infancy neither self nor social grooming ordinarily appears. . . . *From infancy onward, grooming* as *social response* becomes increasingly definite and frequent until maturity is achieved" Since "infancy" in the chimpanzee includes approximately the first three years of postnatal life, it would seem that this statement is not in full accord with the above findings of Jacobsen, Jacobsen, and Yoshioka, in which grooming behavior was reported present by the thirty-ninth week Nor would it seem that the data justify the conclusion that such behavior is innate or structurally conditioned In fact Yerkes himself reports unpublished data of Nissen showing the total absence of delousing activity in two one-year old chimpanzees, even when the animals became infected with body lice "*Neither* self *nor* social grooming or delousing occurred A third animal, about two years of age, made no effort to delouse himself, but when he was placed with individuals a year or two older the lice promptly disappeared" Yerkes concludes that some of the facts suggest inheritance, others acquisition of grooming reactions·

> Obviously, unless *the activity has inherited structural* basis in the individual, it cannot be assumed to have phylogenetic history in the primates In the present stage of my inquiry I am inclined to think *that the evidence is slightly* in *favor* of the hypothesis . . that grooming is an inherited pattern of

response whose racial history may be traced imperfectly in the existing primates

At no time in the present investigation was there the slightest evidence of auto-grooming. Nor did the infant macaque ever exhibit grooming behavior when confronted during the observational periods with the cotton batting, albino rat, guinea pig, cat, adult rhesus monkey, or the hands, arms, or hair of the observer. Clutching, scratching, and, at a later date, gross manipulatory reactions were very common, but the detailed pattern of grooming behavior as defined by Yerkes was not observed Jaw movements, present in other situations, never appeared on such an occasion, nor did the infant ever indulge in such behavior as Kohler has characterized as flea-picking, hair-dressing, skin-treatment, or toilet-making The fact that the present subject was clean and free from parasites may indeed be a factor in the absence of such behavior.

Thus it would seem that the question of the ontogeny of grooming and auto-grooming behavior is still unsettled. Such reactions were not observed in the present subject at birth, nor did they occur during the first year If this finding continues to hold, it might be due to the fact that, since the animal was reared in isolation, there was no opportunity for the acquisition of such responses. If grooming reactions were subsequently to occur, they might be interpreted either as (1) learned or experiential or (2) instinctive or "maturational" phenomena More data are needed, including experiments with subjects reared in isolation and in close association with animals of known behavioral characteristics It would seem to the writer at present, however, that so-called primate grooming behavior is not some mystic instinctive "spring" of action dependent upon neural maturation, but rather a definite response acquired from interaction with other individuals or else a development, modification, or differentiation of the scratching or manipulatory reaction to a visual, tactile or irritating stimulus. Why the reaction pattern must be considered social when the stimulus (scab, parasite, hair, etc) is located upon some other animate object rather than the same or inanimate object is also difficult to understand, but this is a common misapprehension in social psychology, which classifies more often in terms of misnamed "stimuli" than in terms of actual behavior patterns

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LE DÉVELOPPEMENT PENDANT LE PREMIER AN D'UN SINGE RHÉSUS (Macaca mulatta) ÉLEVÉ DANS L'ISOLEMENT

(Résumé)

Cet article décrit l'étude du développement pendant le premier an d'un singe rhésus (*Macaca mulatta*) élevé dans l'isolement. L'âge de gestation du sujet a été 167 jours, et l'on a pris le petit par force à la mère à l'âge de 3 jours, et on l'a élevé après avec succès complètement isolé de la mère et des autres membres de l'espèce

La partie préliminaire de l'article montre la valeur et la nécessité de l'approche et comparative et génétique aux problèmes du comportement psychologique. On cite des expériences sur la croissance et le développement du comportement de diverses formes des animaux, en se rapportant surtout à une considération des primates L'autre partie de l'article décrit l'expérience elle-même, y compris la description du *problème*, de *l'habitat*, de la *nourriture*, et de la *discussion des résultats* On rapporte quand possible les données applicables des autres investigations. On discute les résultats sous trois titres.

(1) Le *développement physique*, y compris l'apparence générale, le poids, les proportions du corps, et l'éruption de la dentition décidue

(2) Le *développement sensori-moteur et celui du comportement simple*, y compris des données sur le développement fonctionnel des modalités sensorielles, des réflexes, et d'autres réponses motrices simples

(3) Le *développement du comportement complexe*, y compris une discussion du comportement en prenant la nourriture, de la vocalisation, de la préhension et de la manipulation coordonnées, de l'usage des mains, du comportement émotif, des manières individuelles, de l'habitude de sucer le pouce, des réactions anormales, des réactions aux autres animaux et à un miroir, et des soins pris de la propreté.

FOLEY

DIE ERSTJAHRIGE ENTWICKLUNG EINES RHESUSAFFEN (*Macaca mulatta*), DER IN ISOLIERUNG AUFGEWACHSEN IST

(Referat)

Diese Untersuchung handelt von der erstjahrigen Entwicklung eines Rhesusaffen (*Macaca mulatta*), der in Isolierung aufgewachsen ist Das Trachtigkeitsalter war 167 Tage, und das kleine Tier wurde mit Gewalt von der Mutter entfernt, als es drei Tage alt war, und nachher wuchs es erfolgreich in vollkommener Isolierung von der Mutter und anderen Mitgliedern der Gattung auf.

Die Einleitung dieses Aufsatzes weist auf den Wert und die Notwendigkeit sowohl einer vergleichenden als auch einer genetischen Behandlung des Problems des psychologischen Verhaltens Experimente uber Wachstum und Entwicklung des Verhaltens der verschiedenen Tierformen mit besonderer Berucksichtigung der Menschenaffen werden angegeben Der Rest des Aufsatzes handelt von dem eigentlichen Experiment, der eine Beschreibung des Problems, Fundorts, der Diat, und eine Erorterung der Ergebnisse enthalt Daten aus anderen Untersuchungen werden womöglich angegeben. Die Ergebnisse werden unter drei Ueberschriften erortert:

(1) Physikalische Entwicklung, einschliesslich des allgemeinen Aussehens, des Gewichts, körperlicher Verhaltnisse, und des Ausschlags ausfallenden Zahnens.

(2) Sinnes-motorische Entwicklung und einfache Entwicklung des Verhaltens, einschliesslich Daten uber die funktionelle Entwicklung der Sinnesmodalitaten, Reflexe, und anderer einfacher Motorreaktionen

(3) Komplexe Entwicklung des Verhaltens, einschliesslich einer Besprechung des Fressverhaltens, der Vokalisation, des koordinierten Ergreifens und der Handhabung, des Gebrauchs der Hande, des Gefuhlsverhaltens, der Manieriertheiten, des Daumensaugens, der anomalen Reaktionen, des Verhaltens gegen andere Tiere und gegen einen Spiegel, und des Pflegens

FOLEY

THE CENTILE STATUS OF GIFTED CHILDREN AT MATURITY*[1]

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THE PROBLEM STATED

The present investigation was planned to contribute toward answering the question, what will be the intellectual status of gifted children, as they approach and reach maturity? More specifically, we aimed to discover what would be the centile status at maturity of children who in 1922 tested in the top centile of school children, by Stanford-Binet, i e, above 130 IQ.

PREVIOUS CONTRIBUTIONS TO THE PROBLEM

Adequate study of this problem involves long-time observation of the same individuals. The majority of relevant studies previously made have dealt with the generality of children, and have covered from one to six years of time These studies have borne upon our problem by showing what the degree of constancy of the IQ is for children in general For the periods of time covered in these investigations, the constancy of the Stanford-Binet IQ is of a high order Recent surveys of the collected data (3, 15) reveal that the correlation coefficient obtained between separate tests made on the same children diminishes somewhat with the lengthening of time

Kuhlmann's ten-year study of inferior deviates (8) demonstrates that groups of feebleminded children remain feebleminded as they reach maturity, while Chipman (5) notes that the IQ (S-B) is reliable within ±4, in 80 per cent of institutional cases, for prediction of limit of mental development in mental defectives, using sixteen as the age of maturity.

Baldwin and Stecher (1) followed the development of a group of children clustering at about 120 IQ (S-B), in comparison with an average group, and showed the former to remain constantly above the latter, as all approached maturity.

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[1]Reported at the Cleveland meeting of the American Educational Research Association February 28, 1934

As regards children in the top centile on Stanford-Binet, previous data have been supplied by Terman (12) In Terman's study, 292 adolescents between the fifteenth and twentieth birthdays, identified six years previously by Stanford-Binet as having IQ's at or above 140, were retested by means of the Terman Group Test, and were proved to earn high scores. A sample of these adolescents were also tested by means of the Thorndike College Entrance Examination, and rated high. Comparative centile status was, however, not determined in this study. The Terman Group Test, like Stanford-Binet, is exhausted by the gifted early in adolescence It has insufficient "top" The Thorndike College Entrance Examination has attached to it no distribution of the general population, from which centile status, comparable to centile status on Stanford-Binet, can be determined Terman's investigation clearly shows a strong tendency for children who test above 140 IQ (S-B) to maintain high status, a tendency which is stronger in his sample for boys than for girls

From previous data, therefore, it would be expected that gifted children will tend to maintain superiority as they mature We wish to discover as exactly as possible what this tendency will be, *in terms of centile status* Even this determination will not, of course, be very precise, since any centile covers a range of intellects, the top centile covering a very wide range

THE SUBJECTS OF THE PRESENT STUDY

The subjects of the present study were identified in childhood as testing above 130 IQ (S-B) Nearly all of those included were identified in the course of experimentation with special classes for gifted children, at Public School 165, Manhattan (6), under the auspices of a joint committee[2] The children were of the ages shown in Tables 1 and 2, at the time of testing by Stanford-Binet. Nearly all were identified in 1922 or 1923 In the original sample identified there were 148 children As tending to avoid the regression on retesting which occurs from any extreme centile as a function of the probable error of a single test, when the line of

[2]This committee included Mr Jacob Theobald and Miss Jane E Monahan, of Public School 165, Manhattan, Dr Grace A Taylor, Miss Margaret V Cobb and Prof Leta S Hollingworth, of Teachers College, Columbia University The work of this committee was supported for two years, from 1923-1925, by funds supplied by the Carnegie Corporation, of New York

first testing is drawn *just at* the lower limit of a centile, we included in our original sampling no child testing below 133 IQ, though the top centile of Terman's distribution is drawn at 130 IQ.

During 1932 and 1933, one hundred and sixteen of these children were retested, by means of Army Alpha.

Fifty-six of the subjects originally tested had been recorded as a sample to be observed with absolute completeness for ten years All but two of these are among those finally tested by Army Alpha, and all pertinent circumstances connected with the absence of the two missing subjects are known. They failed to be included in the final tests because one was in England and one in California at the time They were not lost from the sample through any peculiarities of development. Data are at hand regarding the status of these two boys in 1929, as follows, from which it will be clear that one of them had already reached the top centile of the Army Alpha distribution at that time.

Subjects missing from final test of completely observed sample	IQ (S-B)	Age	Alpha Score 1929	Form	Age
123	160	9-0	193	5	15-0
146	135	7-8	159	5	14-6

We thus have a large *sample of our original sample* which has been one hundred per cent accounted for by the investigators, either as finally tested, or as missing for the definite reason of removal to a distance too great to cover This sample was selected at the outset for complete observation because the children composing it were in special opportunity classes in 1922-23, and it was therefore believed that lasting acquaintanceship would arise between them and the investigators (6) This proved to be the case They were not selected on any other basis.

The manner in which these fifty-six children are distributed in relation to our total original sample may be seen by inspection of Tables 1 and 2, which give the original IQ's of the retested subjects, and of those missing from the retest, respectively These fifty-six are well distributed throughout the total sample, and there is, therefore, no reason to assume that the 32 subjects missing from our retest would change our results if they had been included. The fallacies of selection have been avoided by following a *sample of our sample,* with a complete record of it

TABLE 1

PRESENTING TOTAL DATA ON AGE, SEX, AND TEST SCORES OF 116 INTELLECTUALLY GIFTED CHILDREN, RETESTED AT OR NEAR MATURITY

Asterisks show children belonging to the sample that was one hundred per cent observed, from start to finish of the study

Subject	Sex	IQ (S-B)	Age yrs	Age mos.	Army Alpha score	Form of Alpha	Age yrs	Age mos
* 1	M	190	9	3	210	8	19	6
* 2	M	188	9	4	198	8	18	2
3	M	187	6	6	205	8	18	6
4	M	178	7	7	188	5	15	10
5	M	177	7	11	194	7	18	2
* 6	M	175	9	1	193	8	19	1
7	F	174	7	5	192	5	17	6
8	F	173	7	1	181	5	16	1
* 9	M	172	7	4	188	8	18	2
* 10	M	171	8	8	194	8	19	5
* 11	M	171	8	4	198	8	18	7
* 12	F	170	8	1	180	8	19	0
13	M	170	9	2	186	7	21	0
* 14	M	168	7	2	191	8	17	7
15	M	168	9	6	193	8	19	8
* 16	F	167	9	0	197	8	19	1
* 17	M	167	6	7	191	8	16	8
* 18	F	164	8	7	194	8	19	3
* 19	M	163	7	6	183	8	18	5
* 20	M	162	8	8	192	8	19	3
* 21	F	162	8	8	169	8	19	1
22	M	161	8	0	175	7	15	11
* 23	F	160	7	8	188	8	18	4
24	M	160	5	6	188	8	15	7
25	M	159	4	11	194	7	17	2
* 26	M	158	9	7	186	8	19	6
27	F	158	8	8	161	5	17	6
28	M	157	7	2	189	5	15	9
* 29	M	157	8	3	195	8	18	9
* 30	F	157	10	10	187	8	19	5
* 31	M	157	7	3	187	8	18	2
* 32	F	157	9	5	189	8	19	1
33	F	157+	11	0	197	7	19	0
34	M	156	8	8	189	7	18	0
* 35	M	156	9	3	207	8	19	4
* 36	M	156	9	9	200	8	20	0
* 37	M	156	8	11	194	8	19	0
38	F	156	7	5	188	5	16	6
39	M	155+	11	8	197	5	18	3
* 40	M	154	8	6	153	8	18	11
* 41	F	154	9	8	168	8	19	7
* 42	M	154	7	8	199	8	17	11
* 43	M	153	8	1	184	8	18	7
44	M	153	10	2	177	7	18	6
* 45	M	153	8	7	191	8	18	11
46	M	153	10	11	179	7	19	0
47	M	152	7	2	173	7	15	7
48	M	152	11	4	197	7	18	10
* 49	F	152	9	8	175	8	19	6
50	F	152	6	9	172	7	15	8
51	F	151	7	11	167	5	15	6
52	M	151+	11	4	184	7	18	11
* 53	F	151	8	6	183	8	18	8
* 54	M	150	9	6	189	8	20	4
* 55	M	150	9	2	198	8	19	9
* 56	F	150	9	0	191	8	19	0
57	M	150	7	6	179	7	15	9

TABLE 1 (*continued*)

Subject	Sex	IQ (S-B)	Age yrs	Age mos	Army Alpha score	Form of Alpha	Age yrs	Age mos
58	M	148	8	6	185	8	18	0
59	M	148	9	5	161	7	19	1
60	F	147	10	6	150	7	17	4
* 61	F	147	9	8	192	8	19	5
62	M	147	9	5	188	7	18	11
63	M	146+	13	0	189	7	19	7
64	F	146	7	5	153	7	16	6
* 65	M	146	8	1	175	8	18	4
* 66	M	146	9	0	187	8	19	7
* 67	F	145	9	3	193	8	19	3
* 68	F	145	9	4	159	8	19	7
69	F	145	8	1	169	7	17	8
70	M	145	8	2	186	7	16	7
71	F	145+	11	2	170	7	17	9
* 72	F	145	8	11	192	8	19	3
73	F	144	8	9	159	7	18	3
74	F	144	8	4	110	7	18	0
75	M	144	6	4	177	7	15	7
* 76	F	144	8	10	171	8	19	4
77	F	143	11	8	175	8	19	4
* 78	F	143	8	0	164	8	18	8
* 79	M	142	8	3	193	8	18	10
* 80	M	141	8	3	160	8	17	9
* 81	M	141	8	6	205	8	18	7
82	M	141	9	5	179	7	18	10
* 83	M	141	8	4	183	8	18	7
* 84	M	141	9	8	182	8	19	11
* 85	M	140	8	11	196	8	19	6
86	F	140	8	1	169	8	18	4
87	F	140	6	9	157	7	15	7
88	M	140	8	7	189	7	18	1
89	M	140	7	4	159	7	16	1
90	M	139	7	9	165	7	17	3
91	M	139	8	9	165	7	18	4
* 92	M	139	9	0	183	8	19	2
93	F	138	10	11	183	5	16	4
94	M	138	8	6	164	7	17	3
95	F	138	8	7	166	8	18	11
96	M	138	8	3	171	7	17	3
97	M	138	8	5	183	5	16	10
* 98	M	138	8	3	175	8	18	10
* 99	F	138	8	1	174	6	18	8
*100	M	138	8	6	167	8	18	8
*101	M	137	9	2	185	8	19	8
102	M	137	7	7	171	7	16	5
*103	F	137	11	8	171	8	19	11
104	M	136	8	4	164	7	17	4
105	F	136	6	6	151	5	17	7
*106	M	135	8	3	190	8	18	10
107	M	135	8	6	153	7	18	0
108	M	135	6	8	163	5	15	9
109	F	134	9	0	113	7	18	0
110	M	134	8	4	190	8	18	2
111	F	134	7	8	182	7	17	1
112	F	133	8	1	156	7	17	3
113	M	133	9	1	170	7	17	9
114	M	133	8	7	150	7	18	2
115	M	133	7	8	183	7	17	6
116	M	133	9	3	151	8	18	8

TABLE 2

PRESENTING ORIGINAL DATA ON SUBJECTS MISSING FROM THE FINAL TEST, BY ARMY ALPHA

Asterisks show children belonging to the sample that was one hundred per cent observed from start to finish of the study

Subject	Age		IQ (S-B)	Sex	Subject	Age		IQ (S-B)	Sex
117	8	6	176	F	133	9	10	148	F
118	11	6	170+	M	134	8	6	145	M
119	8	7	169	M	135	9	8	144	M
120	8	7	164	F	136	8	8	143	F
121	9	7	161	M	137	7	2	142	F
122	10	2	161	M	138	7	5	142	M
*123	9	0	160	M	139	8	3	140	M
124	10	9	158	M	140	7	4	140	M
125	8	1	155	M	141	7	2	140	F
126	8	2	155	M	142	8	6	139	F
127	10	5	154	F	143	8	8	138	M
128	11	2	153	F	144	9	2	137	M
129	9	0	153	M	145	8	9	136	M
130	10	2	150	F	*146	7	8	135	M
131	11	0	148	M	147	8	9	135	M
132	9	6	148	M	148	6	3	135	M

THE AGE OF MATURITY

Our subjects had all passed the fifteenth birthday at the time of final measurements reported here Their ages appear in Table 1. The median age at the time of retest, by Army Alpha, is 18 years 6 months.

We proposed to determine centile status *at maturity*, but the age at which intelligence tests cease to yield an increment is not precisely known. In various studies of the matter, ages all the way from thirteen (7) to twenty-two (14) have been suggested The age which seems most probable is about sixteen years, for the average. Thorndike's studies of high school pupils (13) suggest that adolescents of better than average intelligence continue to show increments on mental tests up to eighteen years, and have not been proved to cease then, since the tests were not carried beyond that age These data are not, however, entirely free from fallacies of selection

As bearing upon this point, fifty-two of our subjects were retested by Army Alpha at a median age of 15 years 1 month (with Form 5) (9), and again at a median age of 19 years 1 month (with Form 8) The median gain is 12 points, with a median

variation of ±5 points, and a range of from —2 to 30 points From Figure 1 it is apparent that Form 5 is about 5 points easier than Form 8; so that the gain would presumably have been 17 points, had forms of exactly equal difficulty been used.

A growth of 17 points in four years, for adolescents of such high degrees of intelligence, is unimpressive, and suggests that the limits of ability to earn points on Alpha were rather closely approached even at the age of fifteen years. Terman (12) found in retesting his group of the gifted by the Terman Group Test that "the interval between medians decreases with age, and becomes small after age fourteen."

On the basis of existing data, we feel justified in concluding that our group, at the date of the Alpha test here recorded, was close to maturity, and that subsequent increments by growth will be slight, if any.

Choice of Instruments of Precision

For distribution of the intelligence of children, Stanford-Binet is, and long has been, one of the best, and probably the very best, of all instruments available Its reliability has been demonstrated many times, and its validity in the case of the gifted has been proved by the criterion of scholastic achievement, over a period of three years (4). Since our subjects all tested in childhood above 130 IQ (S-B), they fell into the top (or hundredth) centile of school children, according to Terman's distribution of 905 cases (11)

For the determination of centile status at maturity there is no instrument or distribution as satisfactory as in the case of Stanford-Binet for children. The literature contains in fact only one distribution of adults that approximates a representative sample of the total population This is the distribution in the military draft of 1917-18, of men between twenty-one and thirty-one years of age, by means of the various forms of Army Alpha (17). This sample of adults is not wholly unselected, but it is approximately so. The sample is very large, and the hundredth centile of it is the best indication we have, or shall be likely to have save for repeated governmental action, of what the best one per cent of our adult population can do on a mental test. Therefore, we chose Army Alpha as our instrument for distributing the gifted at maturity in centiles

The boys and girls included in our completely observed sample had taken Army Alpha in 1924, and again in 1929 (9), but no form of

Alpha was repeated with any subject As there are five available forms of Alpha, this was easy to accomplish. The sixty-two subjects outside the completely observed sample had never taken Army Alpha before, so far as known to themselves or the investigators.

It may well be said that certain items of Army Alpha are now obsolete This criticism applies to the General Information Test Names of movie actresses, and advertising slogans, for instance, which were current in 1917, would constitute esoteric knowledge in 1933. The penalty upon our group from this cause is, however, slight—probably not more than three or four points—and would tend to be offset by the fact that part of our 116 subjects were "test-wise," ("test-wisdom" tending to increase scores) It was indeed interesting and amusing to discover how much of this knowledge that was current when these subjects were two or three years old is still in their minds, e g, the old name of the Brooklyn baseball team, and the trade name of Velvet Joe The boys and girls frequently commented adversely upon these items, saying, "People might not know that nowadays," "That is old stuff," etc

The Stanford-Binet tests were given by four different psychologists, all well trained for their work The Army Alpha tests were given in 1932 and 1933 by the senior investigator reporting the present study, and were administered to the subjects for the most part in groups A few of the tests were given to one individual at a time

The various forms of Alpha differ but slightly in difficulty, as shown in Figure 1. We used Forms 7 or 8 for 88 5 per cent of our cases The proportionate use of forms, with their values, is seen in Table 3 The average of median scores for all forms of Alpha taken together is 62.9 points The average score value

TABLE 3
SHOWING THE VALUES OF THE MIXTURE OF FORMS OF ARMY ALPHA USED IN TESTING

Number of subjects	Form of Alpha	Median value of Alpha
62	8	61 7
41	7	64 3
12	5	66 8
1	6	60 9
Average value for mixture used		63.1+

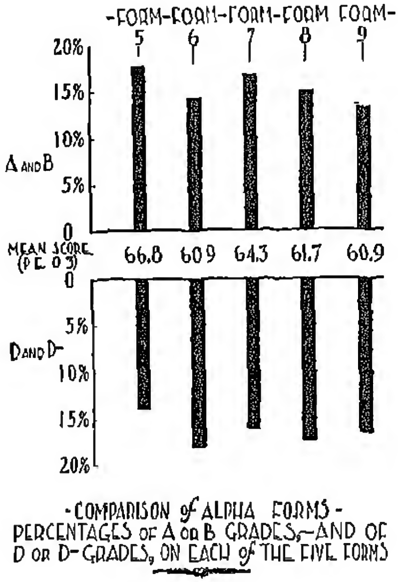


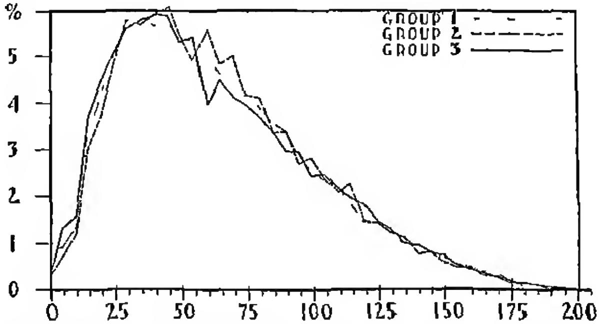
FIGURE 1
SHOWING THE COMPARATIVE DIFFICULTY OF THE VARIOUS FORMS OF ARMY ALPHA
From Memoirs of the National Academy of Sciences, Vol. 15, 1921

for the mixture of forms in our final test is 63.1 points. In our testing we thus used forms that are neither the easiest nor the most difficult. They afford, in fact, an almost exactly median chance to score.

Research has indicated that girls and boys respond in much the same way to Army Alpha (10). It is true that we have never had a large representative sample of our adult female population tested by any means; but somewhat closely comparable *selections*, such as high school boys and high school girls, college boys and college girls, yield closely similar scores on Alpha. The girls in all these selections score a few points below boys—on the average, about 6 points below, and this discrepancy is located largely in results on the General Information Test in Alpha, which was standardized with more items from men's experiences than from women's experiences (16).

Centile Distribution by Alpha

In three different large samplings of drafted men, between twenty-one and thirty-one years of age, of sufficient literacy and intelligence to take Army Alpha, and tested by the various forms of it, the top (or hundredth) centile falls at and above approximately 165 points. For these combined samples of the white draft, the top centile (1.06%) is drawn at 165 points. Figure 2 shows these facts graphically.



PERCENTAGE DISTRIBUTION OF THE ALPHA SCORES OF MEN IN GROUPS 1-2-AND-3 WHO WERE GRADED ON THE BASIS OF ALPHA

FIGURE 2

Showing the Percentage Distribution of Men of the White Draft Who Were Admissible to Alpha

From Memoirs of the National Academy of Sciences, Vol. 15, 1921.

The extreme skewness of Figure 2 is, of course, due to the fact that Army Alpha piles up zero scores for men who fall below a mental age (S-B) of 8 years 0 months. In other words, Alpha does not have sufficient "bottom." The *Memoirs of the National Academy* state these facts thus (17):

> Since in Alpha the zero points in most of the tests are relatively high in the scale of intelligence, many individuals of low intelligence would obtain negative total scores, if their intelligence could betray itself in appropriate negative scores in each of the component tests. As it actually works out, the low-grade individuals are improperly piled up, in the total distribution, above the zero point. (p. 622.)

Taking the distribution from those in Figure 2 which is most

typical, that of Group I, as the best we have, though faulty, for adult intelligence in the United States, we find that 95 of our 116 subjects, when tested as they approach close to maturity, reach the top centile. Nineteen fall at or above the ninety-seventh centile. Two fall below the ninety-seventh centile, both girls, aged 18 years at the time of testing. Figure 3 presents these facts graphically.

It is thus true that 82 per cent of our gifted group fall, at maturity, into the same centile of the white draft (all of our subjects

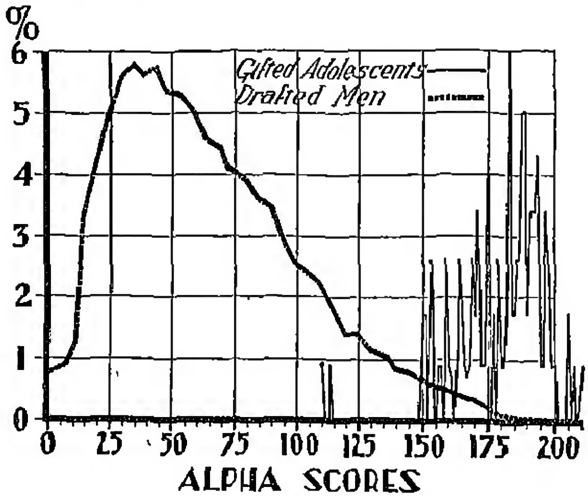


FIGURE 3

SHOWING THE PERCENTAGE DISTRIBUTION OF ADOLESCENTS, WHO AS CHILDREN RATED ABOVE 130 IQ (S-B), IN COMPARISON WITH THE PERCENTAGE DISTRIBUTION OF THE WHITE DRAFT, IN POINTS ON ARMY ALPHA

belong to the white race) on Army Alpha which they occupied in childhood among school children on Stanford-Binet, and the remainder very nearly reach this status. No individual regresses to average, as development terminates

Bearing in mind the probable error of both tests, and that these findings are based on but one trial of each test, this result is very consistent. The probable error of a single test on Stanford-Binet is ±5 IQ. The probable error in points for a single test on Army Alpha is not exactly known Yerkes and Yoacum (18) state that

this error is approximately ±5 points. The reliability coefficient for a test is said to be .95, but no details are cited. Had reliability been increased in our study by combining at least *two* trials of each test involved, the predictability of centile status for the top centile of school children would be increased to practically complete reliability. The twenty-one subjects who regressed from the top centile are disproportionately girls, and those under 18 years of age. The median age at testing for our total group was 18-6. For those who regressed, it was 17-9. If we restrict our count to *boys who had passed the eighteenth birthday,* we find that 90.3 per cent reach the top centile of the Alpha distribution of the white draft, with the remainder at or above the ninety-seventh centile.

There is still to be considered the scale of Alpha scores for centile distribution of the total population, communicated by Bregman (2). This scale is "based upon the distribution of scores made by the native white draft who could take the Army Alpha examination, plus the scores made by officers in the proportion of 20 to 1."

In our judgment, a scale thus modified by theoretical computations probably places the top centile too high, because many of those who could *not* take Army Alpha failed to do so on account of low intelligence (which automatically results in illiteracy). It has been shown that a mental age (S-B) above 8-0 is required to score on Alpha (17). Thus to add officers' scores, but not to add zeros for mental defectives, also missing from the distribution of Alpha, would surely tend to push the demarcation of the top centile beyond what it should be, for the total population. It seems, indeed, to the present investigators quite probable that native illiterates excluded *more than* counterbalance the absence of officers, so that the demarcation of the top centile even as it stands in Figure 2 (at 165 points) is very likely too high.

On this point the *Memoirs* state (17):

> Of the 1,566,011 men (tested), 25.3 per cent were "unable to read and understand newspapers and write letters home," and were given the Beta examination for illiterates. An additional 5.7 per cent, after failing the Alpha for literates, also were given the Beta examination. It is estimated that more than half of this 31 per cent were native born Americans (p. 100.)

It is therefore clear that many low-grade intellects are missing from the distribution of "those who could take Alpha," which should

be included at the low end, if officers' scores are to be included at the high end, for correction

The scale proposed by Bregman would draw the top centile for the total population at 174 points. This line of demarcation would include 78 (67.2 per cent) of our 116 subjects. It might perhaps be reasoned that the closer agreement of our data with the uncorrected distribution of Alpha scores argues for its greater soundness, as compared with the corrected distribution proposed.

The form of Alpha prepared by Bregman (2) to eliminate obsolete and sex-limited items from the General Information Test was not used in our study, because it has not been tried out on an actual representative population, to obtain a distribution of scores.

Summary

Of 116 children testing in the top centile of the distribution of school children by Stanford-Binet, eighty-two per cent were found when near maturity, ten years later, to rate in the top centile of the military draft by Army Alpha. The remainder rated in high centiles. No individual of either sex regressed to or nearly to average. Fallacies of selection were avoided in the follow-up by complete observation of a representative sample (n=56) of the total number of subjects (n=148) originally identified in childhood. Girls regressed from the top centile somewhat more frequently than boys, this regression being in part but not fully accounted for by the known sex-difference between medians on Army Alpha.

This result affords a validation, by means of elapsed time, of the predictive power of available mental tests on the one hand, and on the other hand, a proof of the constancy of the intellectual development of gifted children in terms of centile status.

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L'ÉTAT CENTILE DES ENFANTS BIEN DOUÉS À LA MATURITÉ

(Résumé)

De 116 enfants, tous trouvés dans les tests dans le centile supérieur de la distribution des écoliers selon le Stanford-Binet, 82% se sont montrés quand pres de la maturite, dix ans plus tard, dans le centile supérieur de la conscription militaire, selon l'Army Alpha Les autres se sont montrés dans des centiles élevés Aucun individu des deux sexes n'est revenu à la moyenne ni à près de la moyenne On a évite des fautes de sélection dans les nouveaux tests au moyen d'une observation complete d'un échantillon représentatif (56) du nombre total des sujets (148) originairement identifiés dans l'enfance Les jeunes filles ont fait une régression du centile supérieur un peu plus fréquemment que les garçons, cette régression etant expliquée en partie mais pas complètement par la différence de sexe connue entre les médianes sur l'Army Alpha.

Ce résultat donne une validation, au moyen du temps passé, de la capacite prédictive des méthodes disponibles de tester l'intelligence, de l'un côté, et de l'autre côté, celle de la constance du développement intellectuel des enfants bien doués, en termes de l'état centile

HOLLINGWORTH ET KAUNITZ

DIE RANGORDNUNG BEGABTER KINDER IN DER REIFE

(Referat)

Bei 116 Kindern, die sich in der obersten Stufe der Verteilung fur Schulkinder beim Binet Test befanden, wurde festgestellt, dass 82% der Kinder zehn Jahre spater, als sie zur Reife kamen, in die oberste hundertteilige Stufe der Militarauswahl bei dem "Army Alpha" Test fielen Die ubrigen fielen in die hohen hundertteilige Stufen Kein Individuum beiderlei Geschlechts fiel in oder beinahe in die Durchschnittsstufe zuruck Fehler der Auswahl wurden bei der Nachprufung vermieden durch die vollkommene Beobachtung einer typischen Auswahl (56) der ganzen Anzahl der Vpn (148), die ursprunglich in der Kindheit identifiziert wurden. Madchen fielen in eine niedrigere Stufe etwas haufiger zuruck als die Knaben Dieser Ruckgang wird zum Teil, aber nicht ganz, durch die bekannten Geschlechtsunterschiede zwischen den Durchschnitten des "Army Alpha" Tests erklart

Dieses Ergebnis liefert eine Bestatigung der Voraussagungskraft der verfugbaren Methoden der Intelligenzprufungen vermittelst der verflossenen Zeit einerseits, anderseits der Konstanz der geistigen Entwicklung der begabten Kinder vermittelst der Rangordnung.

HOLLINGWORTH UND KAUNITZ

ON THE RELATIONSHIPS BETWEEN MENARCHEAL AGE AND CERTAIN ASPECTS OF PERSONALITY, INTELLIGENCE AND PHYSIQUE IN COLLEGE WOMEN*

From the Psychological Laboratory of Stanford University

CALVIN P. STONE AND ROGER G. BARKER

INTRODUCTION

Our primary aim in making this investigation[1] was to study the relations that exist in college women between age at onset of the menses[2] and responses to items of a personality inventory (Bernreuter, 4) While gathering the data for this study it was possible, in addition, to obtain information relative to the intellectual and physical status of the same subjects The relationships between the latter data, the menarche, and the personality data will be reported along with the results from our main study.

The Subjects Data were secured from 336 women attending the San Jose State College and from 258 women enrolled at Stanford University. In both cases the women were entering students and for the most part were in their freshman year. Working from information supplied by the students, we eliminated Orientals, Hebrews, and those of South European stock This was done to avoid introducing irrelevant factors due to racial heterogeneity, as it is commonly believed that American-born children with these racial origins differ in age of pubescence and in physical traits from

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[1]Financial support for this study was provided by a grant from the Committee for Research on Sex Problems, National Research Council, and from the Thomas Welton Stanford fund for Psychological Research, Stanford University We are greatly indebted to Drs. J C. DeVoss and Elizabeth McFadden, who made data on the San Jose State College group accessible to us and to Drs B. S Dyment and C G Wrenn who provided us with the data for the Stanford group. Code numbers were substituted for names when transcriptions from the official record cards were made, hence individual identity of subjects was unknown to those of us concerned with the present investigation

[2]Onset of the menses is regarded as one important sign of pubescence, but not its equivalent The term pubescence embraces a cluster of related phenomena, such as enlargement and pigmentation of the breasts, growth of pubic and axillary hair, changes in certain bodily proportions, rapid growth of the accessory organs of reproduction, and so on

those of middle and north European stock which constituted the major part of the population from which our subjects could be secured

The Data. The height, weight, and chronological age of all subjects were obtained as a part of the routine physical examinations given to matriculating students in the two institutions. Seventy-five of the Stanford women were remeasured[3] for lateral chest diameter at the level of the nipple, for pelvic diameter at the level of the iliac crests, and for height and weight approximately six months after the original measurements were obtained.

The age at first menstruation was ascertained by personal interview at the state college, whereas the university group supplied this information as one item of a comprehensive health questionnaire filled out, with the aid of the parents, about one month before coming to the university No endeavor was made to determine the validity of these basic data on age at first menses by attempting to check the subjects' answers with family records (if such are available), with the remembrance of other members of the household, or by requiring them to relate the menarche to other well dated and easily recalled events in their personal histories. It is unfortunate that this could not be done because errors as to age at first menstruation, like any errors of measurement, would have an attenuating effect upon correlations. The matter seems worthy of special investigation, for we have found no published report throwing light upon the problem.

The state college group received the Bernreuter Personality Inventory, the American Council on Education Psychological Examination for High School Graduates and College Freshmen, and the physical examination during the same week. The university women took the personality inventory approximately two weeks after the physical examination, and received a modified form of the Thorndike Intelligence Examination for High School Graduates about 6 months prior to that time. We know of no reason for thinking that this temporal displacement of the intelligence test in the case of the university group might invalidate its use for the present purpose.

Distributions, Means, and Standard Deviations of Chronological Ages, Menarcheal Ages, and Time Since the Menarche. It was our

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[3]Measurements taken by Mrs H. W Leuenberger, a Research Assistant in Psychology

intention to asemble data from women of the early adult or late adolescent period of life in whom intellectual and physical development had reached such a stage that the relations observed might be considered fairly typical of maturity Concerning the age relations of such personality traits as we were prepared to investigate, little was known beyond the fact that the scores reported for high school junior and senior girls differ very little from those of college women (4)

In Table 1 will be found the percentage distributions, the means, and the standard deviations of the distributions of chronological ages, menarchael ages, and number of years since the first menses As the distributions show, most of our subjects had attained a chronological age at which, according to previous investigations (6), (9), (11), little further change takes place in intelligence, height, and weight with the addition of two or three more years. Also, since 99% of the subjects were two or more years past the menarche, one should expect to encounter very little confusion of relationships that may arise from differential timing of the developmental acceleration associated with the menarche. In the case of stature, and possibly other physical measurements, however, the findings of Boas (5) must not be overlooked He found that girls who reach the menarche relatively late continued to grow in stature relatively longer than those who reach it early There was a small but significant increment in height between the years of 17 and 18 in girls who reached the menarche at 13 years or later, whereas in those who matured prior to that age growth in stature had virtually ceased.

In Table 2 the means and standard deviations of scores and measurements of the college and the university groups are presented for comparison. In it will be found the critical ratios $\frac{\text{difference}}{\sigma \text{ difference}}$ of the differences in the means.

It may be seen that the university women are definitely younger, on the average, and reach the menarche significantly earlier than the state college women The difference in chronological age may be due in part to the fact that scholastic aptitude plays a more important rôle in determining the female population of the university than of the college group; those with the higher aptitudes are usually somewhat accelerated in scholastic standing But still another factor, and one that is more important, is the fact that the Stanford

TABLE 1

Percentage Distributions, Means, and Standard Deviations of Chronological Ages, Ages at the Menarche, and Number of Years since the Menarche for the San Jose State College and Stanford Women (N is 336 for the San Jose group and 257 for the Stanford group)

					Chronological ages							
	16†	17	18	19	20	21	22	23	24		Mean	S D
San Jose	13 9	17 9	36 9	21 7	10 4	5 6	2 4	0 9	0 3		18 97	1 36
Stanford	9 7	41 2	43 6	5 1	0 0	0 4	0 0	0 0	0 0		17 97	0 71
					Menarcheal ages							
	10	11	12	13	14	15	16	17			Mean	S D
San Jose	0 6	9 2	23.5	36 3	22.9	5 4	1 5	0 6			13 47	1 12
Stanford*	0 8	17 8	31.4	28 3	16 3	4 3	1 2	0 0			13 09	1 17
					Number of years since the menarche							
	1	2	3	4	5	6	7	8	9	10	Mean	S D
San Jose	0 3	2 7	7 1	17 6	24 1	20 8	14 0	8 3	3 3	1 8	6 05	1 71
Stanford	0 8	3.5	11 3	24 9	28 0	21 0	7.4	2 7	0 4	0 0	5 34	1 40

*N is 258 in this case

†Each age interval includes the time from the designated birthday to the day preceding the next birthday

TABLE 2

CONSTANTS OF THE DISTRIBUTIONS OF AGES, PHYSICAL MEASURES, AND PERSONALITY RATINGS OF 336 SAN JOSE STATE COLLEGE WOMEN AND 258 STANFORD UNIVERSITY WOMEN

	San Jose State College N = 336		Stanford University N = 258		Diff in Means / σdiff.
	Mean	S D	Mean	S D	
Chron. age (years)	18 97	1 36	17 97†	0 71	11 6
Age at menarche (years)	13 47	1 12	13 09	1 17	4 0
Height (inches)	64 42	2 22	64 83	2 02	2 +*
Weight (pounds)	125 80	20 20	125 50	14.55	0 2
B_1N	—39 40	75 30	—65 61	71.83	4.3
B_2S	0 65	51.73	23 00	57.36	4 9*
B_3I	—26 73	47 11	—38 84	43 30	3 2
B_4D	25.35	57 67	50 87	56.78	5.4*

†N=257 in the case of Chron age
*Indicates the Stanford group has the larger mean.

women from whom data were obtained with rare exceptions entered the university immediately after finishing the secondary school, whereas a greater proportion (possibly 10 to 15%) of our state college group transferred to this institution after a year or more in some other state or junior college.

The difference in menarcheal age may be due, in part, to the existence of a small negative correlation between intelligence scores and the age of first menses As we have already stated, the university group has been more highly selected for college aptitude than has the college group However, this difference in menarcheal age should not be stressed in view of the fact that one cannot be absolutely certain that it is not ascribable to the difference in methods of collecting the data followed at the two institutions (See above)

The differences in height and weight are small and hardly worthy of notice in view of the fact that different technicians, working with different instruments and possibly with slightly different methods of procedure, took these measurements in the two institutions.

With respect to the Bernreuter Personality Inventory, it may be seen that differences between the college and the university groups approach significance in every instance Because of this fact, and

because of the significant difference in menarcheal ages of the two groups, it seemed inadvisable to pool the data from the two institutions. Therefore, although possibly sacrificing some legitimate variability of scores, we have dealt separately with the college and university groups.

Relation of Menarcheal Age To Personality Data, Physical Measurements, and Intelligence Scores

The relationships between menarcheal age and the personality ratings, physical measurements, and intelligence scores are indicated by means of the product moment correlation coefficients given in Table 3. This method of analyzing the relationships appears to be

TABLE 3

Relation of Menarcheal Age to Personality Ratings, Physical Measurements, and Intelligence Scores

Menarcheal age correlated with:	Product moment correlation coefficients San Jose State College	Stanford University
Bernreuter		
B_1N	—.128±.036	+.011±.042
B_2S	—.038±.037	—.098±.042
B_3I	—.137±.036	—.029±.042
B_4D	+.093±.036	—.009±.042
Physical measurements:		
Height	+.153±.036	+.094±.042
Weight	—.059±.037	—.225±.040
*H./w ratio	+.093±.036	+.174±.041
Intelligence	—.175±.036	—.042±.042
Chronological age when examined	+.089±.036	+.083±.042

*This ratio consists of height in inches divided by weight in pounds. The correlation of this ratio with age at menarche and with personality score was computed from a formula given by Lee, Lewenz, and Pearson (14*a*). Dr. Quinn McNemar called our attention to this procedure.

valid in the present instance as Fisher's (7, p. 216 ff) test indicates that in no case is the likelihood as great as one in a hundred that the means of scores and measures deviate significantly from linearity over the entire range of menarcheal age variation. Although the grouping in the menarcheal age variate is necessarily coarse—i.e.,

seven intervals—the error that would result therefrom has been reduced by the application of Sheppard's correction (12, p 167 ff) in the calculation of the standard deviation of this variate. Partial correlation to hold constant chronological age at the time our data were collected was not employed because the zero order coefficients were of doubtful significance in all cases [1]

Menarcheal Age and the Personality Data The coefficients of correlation between menarcheal age and personality test scores do not indicate significant relationships between age at the time of first menstruation and rating for neurotic tendency, for self-sufficiency, for introversion, or for dominance in the case of college and university women who are from 1 to 10 years post-pubescent. Although the correlations with B_1N and B_3I approach significance in the case of the San Jose data, these relations are not borne out by the Stanford data. It may be, of course, that the latter coefficients are in error and that there are, in fact, small negative correlations between menarcheal age and the B_1N and the B_3I This will have to be checked by further investigations The present data strongly suggest that any such associations would be very weak

The items of the Bernreuter Personality Inventory are so weighted as to differentiate four arbitrarily defined personality characteristics (neurotic tendency, self-sufficiency, introversion, and dominance). *A priori,* one may assume that failure to find significant relationships with these scale scores does not preclude the possibility of so weighting the items as to yield scores which would correlate significantly with menarcheal age. This possibility was investigated by the following method. Two groups of 51 subjects each were selected from the Stanford subjects One group consisted of the women whose first menses came at the ages of 10 or 11 years, and

[1] Zero order coefficients not reported in Table 3 are as follows

Chronological age correlated with	Product moment correlation coefficients San Jose group	Stanford group
B_1N	024± 037	019± 042
B_2S	.049± 037	.047± 042
B_3I	—068± 037	035± 042
B_4D	.001± 037	066± 042
Height	036± 037	043± 042
Weight	054± 037	—108± 041
Intelligence	—015±.037	—126± 041

the other group consisted of those whose menarcheal ages were 14, 15, or 16 years The mean chronological age was the same for each group The next step was to determine the proportion in each group marking each item of the personality inventory in one of the three possible ways namely, *yes, no, ?* The groups were then compared with respect to these proportions, item by item, and the standard errors of the differences in the percentages were determined. An inspection of these differences and their standard errors permits us to conclude that with a great majority of the items the groups are not significantly different In some instances, however, differences that are more than twice their standard errors do occur. The question then arises as to whether these are indicative of true differences or whether they may be due to chance factors.

If it should be true that chance sampling errors account for the differences in percentages obtained, it would be expected that the frequency distributions of the ratios obtained by dividing each difference by its standard error would conform to the normal probability integral In Table 4 the obtained frequency distributions and that expected on the basis of this hypothesis are given. When the chi square test (10, p. 245 ff) for the significance of the differences in the obtained and expected frequencies is made, the possibilities that differences as great or greater might arise by chance are 30 in 100 for the "yes" responses, 30 in 100 for the "no" responses, and 2 in 100 for the "?" responses The relatively greater deviation from expectation in the case of the "?" responses is due largely to the great number of failures to make this response by both groups.

TABLE 4

BERNREUTER ITEM ANALYSIS

Theoretical and obtained distributions of critical ratios, $\left[\frac{\text{diff in proportions of criterion groups making each response}}{\sigma\text{diff}}\right]$ for three sorts of response to the 125 items of the Personality Inventory.

Critical ratios	Expected frequency	Obtained frequencies Yes	No	?
2.01 and over	5.5	6	6	1
1 51 to 2 00	11 0	13	10	8
1 01 to 1 50	23 0	23	23	15
0 51 to 1 00	37 5	27	28	38
0.00 to 0 50	48 0	56	58	63

It appears on the basis of this analysis that the distributions of ratios do not differ significantly from the form to be expected upon the hypothesis that the obtained differences are due to chance sampling errors Although this does not constitute proof of the hypothesis that they are of chance origin, it does make it plausible and establishes it as the best assumption pending further definitive work In any case, the differences are small and with the most favorable weighting scheme derived from larger and more stable criterion groups, the correlation of a total score with menarcheal age must be very low

Of course, the foregoing findings should not be used to predict relationships in groups where the variabilities of the characters involved are much greater than those with which we are concerned herein Also, they should not be construed as indicating the absence of important relationships in the earlier stages of adolescence when physical changes are going on at a high rate

Menarcheal Age and Bodily Measurements Referring again to Table 3 it may be seen that the correlation coefficients for menarcheal age and the various physical measurements are small, but apparently represent true relations[5] These correlations are positive in the case of height and the height/weight ratio, and negative for weight. There is consistency in the San Jose and Stanford data in all cases Viteles' (18) and Mills's (15) data for similar subjects confirm these relations also. Viteles obtained a correlation of $-14 \pm .042$ between menarcheal age and weight and a correlation of $+09 \pm 043$ in the case of height Mills dealt only with height, he obtained a correlation of $+148 \pm 026$ between menarcheal age and height

Of special interest is the correlation of menarcheal age with the height/weight ratio, in view of the fact that this latter ratio has been found to correlate relatively highly, 70, with other more elaborate morphological indices (8)

Chest width and lateral pelvic diameter also are of interest in this connection since marked changes in these dimensions are asso-

[5]In view of Gould's (9) data which show that the mean height of college women increases during the four college years (successive measures were made upon the same individuals), and in view of the data of Boas (5) which indicates that late maturing girls continue to grow in stature until a later age than early maturing girls, it appears probable that the correlation with height would be somewhat increased if our subjects were older. This topic deserves further study

ciated with pubescence. Facilities for securing these measurements on all of the subjects were not available, but it was possible to obtain them for seventy-five women, thirty-five of whom reached the menarche at 10 or 11 years and forty of whom reached the menarche at 14, 15, or 16 years. These two groups are at the extremes of the distribution of ages of first menses and roughly represent the first and the fifth quintiles of the distribution of the Stanford group. Small differences were found in the two groups as to pelvic width (intercristal diameter), as to chest width, and in the ratio of pelvic width to standing height. The early pubescent are the wider in both cases and have the greater ratio. The differences divided by their standard errors are 1.4, 1.4, 2.3 respectively. Not being able to secure measurements on the entire Stanford group, we were unable to employ correlational techniques in studying their relation to menarcheal age, but it may be inferred from the data at hand that such correlations would probably be negative and barely approaching significance.

Menarcheal Age and Intelligence. The correlation of menarcheal age and intelligence test score is negative in the two sets of data, but the magnitudes of the coefficients are of doubtful significance. A further estimate of this relation may be obtained by using chronological age at the time the tests were made as rough index of mental ability inasmuch as this age is inversely related to school progress. The correlations between chronological age and menarcheal age being low and positive are in accord with the negative correlations obtained in the case of intelligence test score and menarcheal age. Viteles (18) reports a correlation between menarcheal age and intelligence test score of $+.01 \pm .04$, and between menarcheal age and chronological age at the time of testing of $+.11 \pm .04$.

The Relations of Physical Measurements and Personality Ratings. The coefficients of correlation of height, weight, and the height/weight ratio with the four Bernreuter scale scores are shown in Table 5. Very few of these coefficients approach significance and in the case of those which do there is no consistency as to sign in the two sets of data.

The Changing Relations between the Menarche and Physique, Intelligence, and Personality

The accumulated data of various investigators make it possible at the present time to trace tentatively the relations between the

TABLE 5

ASSOCIATION BETWEEN PERSONALITY RATINGS AND PHYSICAL MEASURES PRODUCT MOMENT CORRELATION COEFFICIENTS

Personality Ratings	Physical Measures: San Jose data Height	Weight	Ht/Wt	Stanford data Height	Weight	Ht/Wt
B_1N	+049± 037	+039± 037	−028± 037	−092± 042	−035± 042	+012± 042
B_2S	−069± 037	+049± 037	−063± 037	+078± 042	+.053± 042	−036± 042
B_3I	+047± 037	+064± 037	−054± 037	−056± 042	−004± 042	−011± 042
B_4D	−0+5± 037	−029± 037	+032± 037	+062± 042	+003± 042	+014± 042

menarche and stature from childhood to the approach of adulthood. A not entirely unexpected, but none-the-less striking, feature of these relations is their changing character—in fact, their complete reversal—during this age interval Boas (5) found that girls who reach the menarche at an early age are, on the average, taller from the age of seven years (earliest age studied) to fourteen or fifteen years. He found, also, that the acceleration of growth rate which precedes the menarche is greater in case of early first menstruations In consequence, the greatest difference in the stature of early and late pubescents occurs in that period when the early pubescents have reached the menarche and the late pubescents have not profited by the pre-menstrual acceleration in growth. However, this puberal superiority of the early pubescents is short lived, for in their case cessation of growth occurs earlier. The shorter initial stature of the late maturing girls appears to be compensated for by their longer growing period, so that by the ages of sixteen or seventeen they tend to be slightly the taller.

Each aspect of these relations has been confirmed by other investigators Baldwin (2, 3), Leal (14), Van Dyke (17), and Abernethy (1) have noted the difference in stature of early and late pubescents during early adolescence Baldwin (2) points out the early cessation of growth in the early pubescents Mills's (15) and Viteles' (18) data, as well as that of the present investigation, confirm the tendency to shorter stature in the early pubescents during the post-puberal stage Therefore, although the course of these relations can be charted only tentatively at the present time, the evidence strongly suggests that the ultimate fate of the initial superiority of girls who mature at a young age is a tendency toward terminal inferiority in stature Further confirmation of these apparent relations and an extension of the studies to embrace the period of early childhood is desirable Evidence respecting the developmental course of the relations between the menarche and other characteristics is even more meager than is the case with height In the case of weight, the pre-puberal relations with the menarche are not known; the data of Baldwin (2, 3), Van Dyke (17), and Abernethy (1) indicate that during the puberal phase of development the early pubescents are the heavier. As has been pointed out in this investigation, in the post-puberal phase the early pubescents tend to remain the heavier. The suggestion is, therefore, that the

course of the weight-menarche relation may be somewhat different from that of the height-menarche relation

In the case of intelligence, the pre-puberal relations have not been clearly established Furthermore, evidence respecting the puberal relations is meager and somewhat conflicting (16). For the post-puberal phase of development no significant relations between intelligence and the age of first menses has been found

Studies of the relations between pre-puberal personality characteristics and the menarche are lacking Pioneer studies of these relations during the puberal stage by such investigators as Abernethy (1) and Leal (13) suggest the possibility that true relations may exist The methods used by these investigators have been necessarily crude, however, and their results can be only suggestive

Our results with the Bernreuter inventory in the post-puberal period give no suggestion of the existence of significant relations between the menarche and such personality traits as it reveals Our methods also are necessarily crude, hence the results should be considered strictly tentative.

Summary

The relation of menarcheal age to scores on the Bernreuter Personality Inventory, to physical measurements, and to intelligence scores have been studied in 338 state college and 258 university women These women varied from 16 to 24 years of age, their *menarcheal ages ranged from 10 to 17 years,* and all of them were from 1 to 10 years beyond the age at first menstruation The following conclusions appear to be warranted:

1. There are no significant relationships between menarcheal age and the Bernreuter ratings for neurotic tendency, self-sufficiency, introversion, or dominance.
2. Individual items do not yield responses that differentiate with certainty between women who reach the menarche at 11 years or earlier and those who reach it at the age of 14 years or later
3. No significant relationships were found between the Bernreuter personality ratings and height, weight, or the height-weight ratio
4. Small but apparently significant positive correlations between menarcheal age and height were found, negative correlations of uncertain significance were found between menarcheal age and weight
5. Intelligence scores and menarcheal age showed no significant relationships.

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SUR LES RELATIONS ENTRE L'ÂGE MÉNARCHÉAL ET CERTAINS ASPECTS DE LA PERSONNALITÉ, DE L'INTELLIGENCE ET DU PHYSIQUE CHEZ LES ÉTUDIANTES UNIVERSITAIRES

(Résumé)

On présente ici pour 338 étudiantes d'un collège d'état et 258 étudiantes universitaires des données à l'egard de la relation entre l'âge ménarcheal et les résultats de l'Inventaire de Personnalité Bernreuter, les mesures physiques, et les resultats des tests d'intelligence. Ces femmes ont varié entre l'âge de 16 et 24 ans, leur âge ménarchéal a varié de 10 à 17 ans, et leur premiere menstruation s'est montrée de 1 à 10 ans auparavant. L'analyse de ces données a indiqué que les corrélations produit-moment entre l'âge ménarcheal et les résultats Bernreuter pour la tendance névrosique, la suffisance, l'introversion, et la dominance n'ont pas été significantes. De plus, les points individuels du questionnaire n'ont pas donné des réponses qui ont distingué d'une façon précise entre les femmes qui sont arrivees au ménarche à 11 ans ou plus tôt et celles qui y sont arrivées à l'âge de 14 ans ou plus tard. Les corrélations produit-moment entre les résultats de personnalité Bernreuter et la taille, le poids, et la proportion entre la taille et le poids n'ont pas éte significantes. Les corrélations produit-moment de $+.153\pm.036$ et $+.094\pm.042$ ont indiqué qu'il peut être une relation positive légère entre l'âge des premières règles et la taille. Les coefficients de $-.225\pm.040$ et $-.059\pm.037$ ont indique une relation négative légère entre l'âge ménarcheal et le poids. Les corrélations entre les résultats des tests d'intelligence et l'âge ménarchéal n'ont pas eté significants.

STONE ET BARKER

UEBER DIE BEZIEHUNGEN ZWISCHEN DEM ALTER DER ERSTEN MENSTRUATION UND GEWISSEN SEITEN DER PERSÖNLICHKEIT, INTELLIGENZ, UND DEM KÖRPERBAU BEI UNIVERSITATSSTUDENTINNEN

(Referat)

Die Daten uber die Beziehung der ersten Menstruation zu dem Bernreuter Personlichkeitsinventar, zu physikalischen Messungen, und zur Intelligenz werden fur 338 Studentinnen auf staatlichen Hochschulen und 258 auf Universitaten gegeben. Die Studentinnen waren im Alter von 16-24 Jahren, das Alter der ersten Menstruation variierte von 10 bis 17 Jahren, und sie waren von 1 bis 10 Jahren jenseits der ersten Menstruation. Die Betrachtung dieser Daten zeigt, dass die Produkt-Moment-Korrelationen (product moment correlations) zwischen dem Alter der ersten Menstruation und den Bernreuter-Resultaten fur neurotische Neigung, Selbststandigkeit, Introversion, und Herrschsucht nicht bedeutsam waren. Die Einzelheiten des Fragebogens gaben keine Antworten, welche mit Sicherheit zwischen Frauen unterschieden, die mit 11 Jahren oder fruher zum ersten Mal menstruierten, und denen, die mit 14 Jahren oder spater menstruierten. Die Produkt-Moment-Korrelationen zwischen den Bernreuter Personlichkeitsresultaten und Grosse, Gewicht, und dem Grosse-Gewichtverhaltnis waren nicht bedeutsam. Dass ein kleines positives Verhaltnis zwischen dem Alter der ersten Menstruation und der Grosse bestand, wurde durch die Produkt-Moment-Korrelationen von $+0{,}153\pm0{,}036$ und $+0{,}094\pm0{,}042$ angedeutet. Die Moglichkeit eines geringen negativen Verhaltnisses zwischen dem Alter der ersten Menstruation und dem Gewicht wurde durch die Koeffizienten von $-0{,}225\pm0{,}040$ und $-0{,}059\pm0{,}037$ gezeigt. Die Korrelationen zwischen den Intelligenzwerten und dem Alter der ersten Menstruation waren nicht bedeutsam.

STONE UND BARKER

THE MECHANISM OF VISION. XI. A PRELIMINARY TEST OF INNATE ORGANIZATION*

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Observations upon young animals [Thorndike, 1911 (4); Fletcher, Cowan, and Arlitt, 1916 (1); Watson, 1919 (5)] and studies of the recovery of vision in congenitally blind patients operated for cataract [Senden, 1932 (3)] suggest that the perception of spacial extent and of depth in the visual field is not dependent upon experience or the building up of a system of motor habits, but is the immediate product of some coordinating mechanism elaborated by growth processes in the absence of visual stimulation adequate for learning The available material is not well controlled, however, either from the standpoint of the past visual experience of the subjects or of the accuracy of the spacial localization. The experiments reported below were devised to give more adequate data upon the accuracy of reaction to visual distance when there has been no opportunity for the formation of specific associations.

METHOD

Rats were reared in darkness from birth to 100 days of age and their thresholds for visual distance then determined with a minimum of practice. Females with litters 2 to 3 days old were placed in small cages within a large ventilated dark box in a dark room. Every second day the box was opened in dim light for not more than 10 seconds while food was supplied. These brief exposures to light, amounting to less than 10 minutes in 100 days, may have given opportunity for the formation of some visual habits They should have been avoided, but we do not regard them as a serious defect in the experiment since, in the first place, the time was too brief for the elaboration of such a system of motor habits as would be required for accurate space perception; second, the maximum dimension of the cages was 25 cm. so that there was not opportunity for formation of motor habits for the range of distances used later in tests; and third, the animals were wild and invariably crouched in the rear of the cages during exposure to light

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For testing the limen for distance in the visual field a modified form of the apparatus previously described by Russell (2) was used This measures the force exerted by the animal in attempting to jump through a predetermined distance from one small platform to another. The animal is placed upon the recording-platform, the landing-platform is placed at a measured distance from the first, the animal is induced to jump, and the force exerted is recorded The apparatus is calibrated to read in grams of force required to displace the pendulum to each scale-reading

The procedure in the experiment was as follows

1 The animal was removed from the dark cage to an artificially lighted room and placed on the recording-platform The landing-platform was placed 5 cm away and the animal forced to step across the gap to the food on the landing-platform. Five repetitions of this were sufficient to establish spontaneous crossing.

2 The landing-platform was removed to 20 cm This was the animal's first sight of the landing-platform at a distance too great to span with the vibrissae. Five trials at this distance were given on each of two consecutive days, to establish spontaneous jumping Between test periods the animals were kept in darkness.

3 After 5 trials at 20 cm. on the second day, the distance between the platforms was increased to 40 cm Records of 3 jumps at this distance were secured. The distance was again reduced to 20 cm for 3 jumps, and again increased to 40 cm for 3 jumps

4 On the following day the animal was given one jump at each of the distances 24, 26, 28, 30, 32, 34, 36, 38, and 40 cm. in chance order.

Experimental Data

Thirteen animals were put through the tests For brevity, their individual records are omitted and only averages for the group are given In general, their records are consistent and for each constant the number of cases failing to conform to the trend of the majority is reported

Preliminary Training On the first jump at 20 cm. (the animals' first attempt to jump to any visual object) all but 2 exerted a force in excess of that required to span the distance Only one fell short of the landing-platform During the practice trials all

the others tended to reduce the force exerted. The averages of the 13 animals for the 10 successive trials were the following:

Trial	1	2	3	4	5	6	7	8	9	10
Average force	13	14	13	10	12	7	7	7	6	7 gms.[1]

First Jump at 40 cm. After the tenth jump at 20 cm. the landing-platform was removed to 40 cm All the animals were disturbed by the change, hesitating, stretching toward the landing-platform, and swaying from side to side When they finally jumped, it was in all but 3 cases with significantly greater force than the last jump at 20 cm. The average force exerted by the 13 animals in the last 5 trials of preliminary training at 20 cm. was 6.8 gms. Their average force for the first jump at 40 cm. was 15 4 gms. On this trial all but one of the animals fell short of the landing-platform, but the increase in force above that at 20 cm. is significant.

The ratios between the average force for the last 5 jumps at 20 cm and the force in the first jump at 40 cm. for each of the 13 animals were the following. Decreased force is indicated by italics

6.8; 4.1; 1.9; 2.4, 3 0; 4.6, 3.4; 3.9; 5 0; 1.4; *0.9; 0.8, 0 7.*

Ten of the animals showed a significant increase in force and 7 of them increased the force by more than 300 per cent

Subsequent Tests at 40 and 20 cm All but one of the animals fell short on the first jump at 40 cm. All were given 2 more trials at this distance The averages for the 3 trials at 40 cm. were 15.4, 19 7, and 26.2. The averages show a progressive increase and the individual scores of every animal showed a similar increase in force The force was still inadequate for the distance, and of the 39 jumps only 5 reached the landing-platform.

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[1]The small amount of force exerted in these trials is accounted for by the animal's first method of jumping For the short distance he usually stands almost erect on his hind feet and tail at the edge of the recording-platform, he stretches forward, overbalances and as he falls forward gives a slight hop with the hind feet, stretches out the forefeet and catches the edge of the landing-platform. For greater distances the method of jumping is entirely changed. The animal crouches with all four feet on the edge of the recording-platform, tenses and launches himself almost horizontally toward the landing-platform With a little practice the latter method is adopted for all distances This fact accounts for the greater force exerted at 20 cm after the animals had jumped at 40

The distance between the platforms was again decreased to 20 cm Since all but 3 of the animals had fallen short in the last jump at 40 cm, we should expect a further increase in force, if the change in the visual situation were ineffective But 10 of the animals immediately reduced the force of their jump, so that the average was reduced from 26.2 to 22 Considerable hesitation and disturbance were exhibited again with the change in distance, which indicates that the first increase in force with the 40 cm. distance was not due merely to an increase in emotional tone

Two more trials were given at 20 cm., resulting in further decrease in force (22 0, 18.8, 14.7 gms in the 3 successive trials) The distance was again increased to 40 cm with an immediate increase of average force from 14.7 to 22 4 Two animals now refused to jump at this distance. Ten of the remaining 11 increased their force. Two more trials at 40 cm brought the average force up to 31 5 gms.

Liminal Tests. Russell (2) has shown that animals reared under normal daylight conditions are able to distinguish intervals of less than 2 cm through a range from 26 to 36 cm His conclusions were based upon the scores of 8 animals with 12 jumps at each distance and the average scores for the group show only one reversal in the force exerted for intervals of 1 cm throughout this range. We could not employ this method with our animals, since it involves too much practice, but decided to give each animal one trial at each 2 cm. interval through a similar range The distances were presented in chance order, thus 28, 38, 34, 24, 32, etc cm. Four of the animals refused to jump at distances above 30 cm. The average scores are based upon the records of the remaining 9

The averages of force for each of the 9 intervals were the following

Distance	24	26	28	30	32	34	36	38	40 cm
Average force	24 3	26 3	26 9	29 4	27 7	32 1	38 5	36 3	41 1 gm

The series contains two reversals of order in the force exerted with increasing distance, but the inversion is of only one place and the figures give conclusive evidence that the limen for distance is below 2 cm throughout most of the range of the test We cannot compare these data directly with the group scores reported by Russell because his figures are based upon the averages of 12 trials for

each rat at each distance and the larger number of trials should decrease irregularities in the scores, even with animals having no lower limen. The individual scores which he gives (2, Table 6) are based upon 12 jumps for each animal and show an average of 1.8 inversions of order for the distance of 2 cm. Our group scores are based upon an average of 9 jumps and give two inversions of order. On the basis of this comparison we may conclude that the limen for distance for the animals reared in darkness is not significantly inferior to that of animals reared in the light.[2]

We may also compare the two groups with respect to the graduation of force to distance. Russell (2, p. 146) presents these figures as percentage of the force for a distance of 26 cm. His data are given with ours in Table 1. The gradation of force is very similar in the two series.

TABLE 1

A Comparison of the Relation of Force in Jumping to Distance to Be Covered for Animals Reared in Daylight and for Animals Reared in Darkness

The force is expressed as percentage of that exerted for a jump at 26 cm. The data for animals reared in light are taken from Russell (1932) and each figure represents the average of 96 records. The others are based upon a single jump for each of 9 animals.

Distance	24	25	26	27	28	29	30	31	32
Percentage force									
"Light" group			100	103	107	111	115	113	117
"Dark" group	87		100		102		112		105

Distance	33	34	35	36	37	38	39	40
Percentage force								
"Light" group	117	121	122	128				
"Dark" group		122		146		138		156

Thus, in so far as the data are comparable, the animals reared in darkness do not seem significantly inferior to those reared in

[2]These tests do not, of course, measure the difference limen for distance but merely give a figure below which the limen must lie and measure the accuracy of discrimination for the interval of 2 cm. The significance of the number of inversions may be estimated by a comparison of Russell's data for pigmented and albino animals. The latter required an interval of 4 cm before they reached an accuracy equal to that of our present series at 2 cm.

light in their ability to graduate the force of their jumps in proportion to the distance to be covered.[3]

Discussion

The results of our experiment are shown graphically in Figure 1. The evidence seems clear that the animals, upon the first experience of a new visual distance, attempted to adjust the force of their jumps to the distance and that, for a series of distances, the force was nearly as accurately graduated as was that of animals reared under normal daylight conditions.

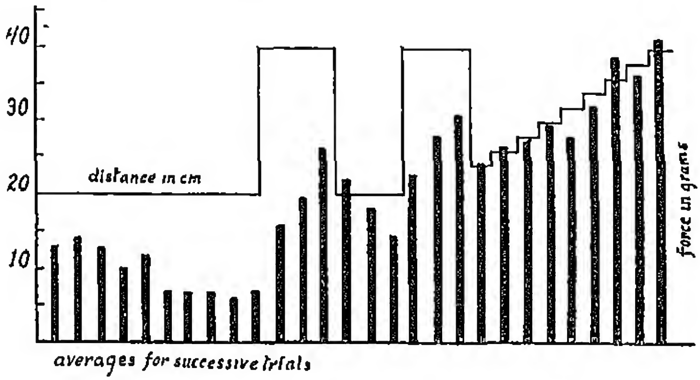

FIGURE 1

Graphic Presentation of the Data of These Experiments

The vertical bars represent the average force in grams exerted by the rats in their efforts to cover the distance represented by the light line above. Successive jumps are represented in order from left to right, except the last 9, which were given in chance order of distance.

The measurement of depth perception in the animals has required some preliminary training in order to establish the reaction used as an indicator. Are this training and the previous visual experience during introduction of food into the dark box sufficient to account for the discrimination of distance shown by the tests? The following considerations seem to compel a negative answer to this question.

[3]Russell's animals were given a great deal of training in jumping in various tests to determine the rôle of binocular vision, etc., in perception of distance before the liminal series was run. The ability of the animals reared in darkness is therefore all the more striking in comparison.

Before the tests the animals had never jumped to a visual object. They had had not more than 10 minutes' exposure to light and not one tenth of this time had been spent in activity which would permit of the association of visual distance with the effort required to cover it by running. The 10 trials of preliminary training were with the landing-platform at a constant distance and therefore offered no opportunity for association of different distances with motor activity. Thus before the first test series there was certainly no chance for the formation of a system of motor habits with reference to visual stimuli at different distances.

With the first increase in visual distance (from 20 to 40 cm.) the animals, which had been progressively reducing the force of their jumps during the 10 training tests, immediately increased the force to more than twice that of the last 5 jumps of preliminary training. This must have involved either a direct adjustment to the new visual distance or a greater tension due to emotional disturbance by the new condition without necessary recognition of the *increased* distance. The latter alternative is ruled out by the fact that with the next shortening of the distance to 20 cm. the animals were again disturbed (as indicated by hesitation and stretching toward the landing-platform) yet immediately reduced the force of their jumps.

With a total previous practice of only 13 jumps at 20 cm. and 6 at 40 cm. the animals then in ten trials showed a difference limen for distance nearly or quite as low as that of animals reared in light. Only one of the distances in this test series (40 cm.) had been experienced before and seven of the animals had never succeeded in reaching the landing-platform at this distance. Yet for this and the 8 new distances they all showed a significant gradation of force.

Tests of this type involve three factors for success in reaching the landing-platform: discrimination of the distance, gradation of the force of the jump in proportion to the distance, and motor coordination for an effective take-off and landing. In the last respect the animals reared in darkness are far inferior to those reared in the light. For distances above 20 cm. more than half of their jumps fell short or missed the landing-platform. The actual force expended was as great as that of the animals in Russell's previous series but the accuracy of control was significantly less.

These facts seem to admit of only one interpretation The discrimination of visual depth and the regulation of the force of the jump in relation to the distance are not dependent upon past experience The association of the perceptual mechanism for visual depth with motor discharges of graded intensity is an inherent property of the reaction mechanism, independent of learning and therefore presumably a product of the growth processes in the nervous system The coordinations in jumping, placing the feet, poising and directing the body before jumping, balancing and placing the feet for a landing, and the adjustment of the absolute energy to the absolute distance to be covered are dependent upon specific learning processes. But underlying these acquired reactions there seems also to be an innate mechanism by which the relative force exerted is immediately adjusted to the relative distance

In the experienced animal the discrimination of distance is a complex affair, involving binocular and monocular parallax, and changes in apparent size and brightness. Which of these enter into the innate discrimination of distance cannot now be determined The elaborate tests necessary to differentiate the various factors would defeat their purpose by the amount of practice which they require

Summary

Thirteen rats were reared to 100 days of age with a total exposure to light of not more than 10 minutes. They were then trained to jump across a space of 20 cm from a platform arranged to record the force exerted in jumping When the distance to be covered was first increased they showed a significant increase in force. Tests of the regulation of the force exerted to the distance to be covered showed nearly, if not quite, as great accuracy as was previously determined for animals reared in light. From these data it is concluded that the visual perception of distance and gradation of force in jumping to compensate for distance are not acquired by learning, but are the product of some innately organized neural mechanism

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LE MÉCANISME DE LA VISION: XI. UN TEST PRÉLIMINAIRE DE L'ORGANISATION INNÉE

(Résumé)

Treize rats ont été élevés à l'âge de 100 jours avec une exposition totale à la lumière de pas plus de 10 minutes. Après on les a entraînés à traverser en sautant une espace de 20 cm. d'un plancher fait pour enregistrer la force exercée pendant les sauts. D'abord quand on a augmenté la distance à sauter, ils ont montré une augmentation signifiante de force. Les tests de la régulation de la force exercée à la distance à sauter ont montré une précision presque mais pas tout à fait aussi grande que celle préalablement déterminée pour les animaux élevés dans la lumière. On conclut de ces données que la perception visuelle de la distance et la graduation de la force en sautant pour compenser la distance ne sont pas acquises par l'apprentissage, mais sont le produit de quelque mécanisme neural organisé d'une façon innée.

LASHLEY ET RUSSELL

DER MECHANISMUS DES GESICHTS: XI. EINE VORPRÜFUNG DER ANGEBORENEN ORGANISATION

(Referat)

Dreizehn Ratten wurden bis zum Alter von 100 Tagen mit einer Gesamtblossstellung zu dem Licht von nicht mehr als 10 Minuten aufwachsen lassen. Sie wurden dann trainiert, von einer Plattform, die die Kraft des Springens aufzeichnete, über einen Raum von 20 cm. zu springen. Wenn der zu überspringende Raum zuerst vergrössert wurde, zeigten sie eine bedeutende Zunahme der Kraft. Prüfungen der Anpassung der aufgebrachten Kraft an die zu überspringende Entfernung zeigten beinahe, wenn nicht ganz, eben solch eine grosse Genauigkeit, wie bei Tieren früher festgestellt wurde, die im Licht aufgewachsen sind. Aus diesen Ergebnissen wurde gefolgert, dass die optische Wahrnehmung der Entfernung und Abstufung der Kraft beim Springen, um die Entfernung auszugleichen, nicht durch das Lernen erworben werden, sondern das Resultat eines angeborenen organisierten Nervenmechanismus sind.

LASHLEY UND RUSSELL

CHOICE-POINT EXPECTANCY IN THE MAZE RUNNING OF THE RAT*

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JACK BUEL AND E L BALLACHEY

I INTRODUCTION

A number of experimenters [Hunter (6), Borovski (3), Liggett (7), Miles (10), Buel (4, 5), Spence (11), Spragg (12), Ballachey (1)] have observed that a disproportionate number of maze errors occur in units in which the blinds point in the same direction as the last true-path turn Thus, in a maze with the true-path pattern r, l, r, l, r, l, the errors will be of greater magnitude in the first, third, and fifth units In those units a turn to the left (a turn into a cul-de-sac) is in the direction of the last correct turn before food

This tendency has been variously described as (*a*) the "retroactive influence of feeding" (Hunter, 6), (*b*) "anticipation" [Lumley (8, 9), Spragg (12), Miles (10)], and (*c*) "choice-point expectancy" (Buel, 4, 5).

Regarding the first of these, Hunter (6) writes

> This phenomenon is similar to that ordinarily discussed under the title "retroactive influence of feeding" I would rather regard the occurrence as an earlier and earlier appearance in the total behavior of that *type* of response which leads immediately to food and exit

This cannot be accepted as a satisfactory statement of the causal conditions in the occurrence of the behavior

Spragg (12) uses "anticipation" in the same sense in which Lumley (8) (9) had previously used the term

> It (anticipation) refers to the experimenter's classification of the animal's response That is, it seems to the experimenter as if the animal anticipates a *turn* which comes later in the series when he makes responses that are not appropriate but would be appropriate if given later in the series (Italics ours.)

*Recommended by Warner Brown, accepted for publication by Carl Murchison of the Editorial Board, and received in the Editorial Office, February 12, 1934

Spence (11) writes, "this factor, then, might more aptly be described as an anticipatory goal reaction, considering the turning left into the food box as a part of the total goal reaction."

Buel (4, 5) bases the "choice-point expectancy" hypothesis "upon the similarity of all units with the last one of the maze. The correct choice in the last unit plus the expected reward is carried as a behavior unit to every other unit in the maze All units are confused to some degree depending upon the linear distance from the last choice, with the last unit of the maze, and the units by their similar structure support such behavior as is correct in the last unit"

It will be seen that the phenomenon has been variously described and that its nature is not clearly understood.

II Purpose

The purpose of the following experiments is an attempt to arrive at a more specific definition of this behavior It is obvious that a definition of any behavior can only be arrived at through a systematic enumeration of the conditions under which it occurs and the conditions under which it fails to occur.

The experimental questions which have been posed are as follows:

1. The nature of the last turn

a Is a *forced* turn followed by food in a unit structurally dissimilar to the other maze units an adequate condition for the establishment of this behavior?[1]

b Is the last turn in the maze effective in causing this behavior when the rat determines its *own preference* (turn) in the last maze unit even though this unit is structurally dissimilar to the preceding units?

c. Must the last unit's turn involve an error to be effective when the last unit is structurally different from the preceding units?

d When the rat is allowed to make a free choice and thus itself determine the direction of the last turn, is this an effective condition provided the maze contains homogeneous units (units identical with the last in the maze)?

[1]The behavior referred to here means choices in the maze which are due to the nature or characteristics of turns later in the maze sequence of true-path turns (last maze turn)

e. Does a turn involving an error support this behavior when the last unit is structurally identical with preceding units?

f When the maze contains units structurally identical and non-identical with the terminal unit, is the distribution of choices similar or dissimilar in these two kinds of units?

2 The last unit's effect as a function of the proximity of homogeneous and non-homogeneous units

a Does the proximity of these two classes of units to the last unit determine in any way the distribution of choices in the maze?

III. Apparatus

The alley maze used in these experiments is diagrammed in Figure 1. The maze was made of unpainted redwood and consisted of three units, *A*, *B*, and *C* Between the units[2] were 3-foot alleys with gates which were raised or lowered by one of the experimenters at the starting position. The floors of the maze were also of unpainted redwood and could be interchanged to control olfactory and tactual cues. The maze was covered with hardware cloth.

Figure 1 gives the dimensions of the 1st, 2nd, and 3rd units. Unit *1* in Figure 1 is a type of unit that we shall hereafter term an *open diamond.* Horizontal lines equidistant from one another were painted on the floors of the 1st and 2nd diamonds. The lines were divided into equal segments as shown, and the segments numbered consecutively from 1 to 16 The rat's path through the open diamond was recorded by tabulating the numbers of the segments over which the animal passed. Unit *2* is the type of unit that will hereafter be termed a *closed diamond.* In unit *B* there is an inner diamond which makes with the outer diamond two alleys in the unit This inner diamond is removable and may be placed inside either the 1st or 2nd units, thus making either one of the two units a closed diamond

D and *T*, the 3rd units of Figure 1, are the two terminal units used in the experiments *D* is a closed diamond identical with the closed diamond of the preceding unit By inserting blocks at *x* or *x'* a right or left cul-de-sac could be made in this unit *T* is a *T*-unit with exits to food at *F* or *F'* By placing a block across

[2]The alleys between units are 3 feet long This length is assumed to be great enough to overcome the effect of centrifugal swing (2)

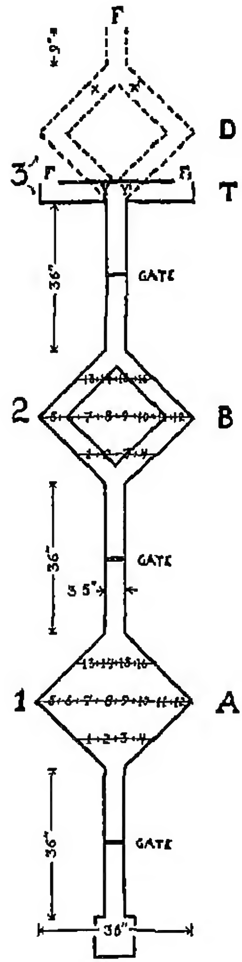

FIGURE 1
DIAGRAM OF THE MAZE

the exits at F or F' either side could be made a blind. By placing blocks at y or y' of the T-unit the rats were *forced* to make a right or left *turn* in the 3rd or terminal unit In all situations involving an error in the T-unit, curtains were placed in each

alley-way of the unit to control visual cues The blocks in the diamond-type terminal unit could not be observed at the choice point so that no curtains were necessary in this unit

The 1st and 2nd units whether "open" or "closed" were *never* blocked The animals were free to take any possible path in the *open* diamond, and to choose either alley (right or left) in the *closed* diamond.

The 1st and 2nd units are also indicated by the letters *A* and *B*. *A* always means unit *1*, *B* unit *2*, so that both the letters and the unit numbers indicate position in the maze

IV. Animals

The animals in groups *TAL(F)*, *TAR(F)*, *TBL(F)*, *TBR(F)*, *TA* and *TB* were obtained from the colony maintained by the Department of Psychology, University of California The animals were males and females approximately three months old. The animals in groups *TAL*, *TAR*, *TBL*, *TBR*, *DA*, *DB*, *DBL*, *DAL*, and *DAR* were donated by the Department of Anatomy, University of California. These animals were all females about three months old

Table 1 gives the schedule of the groups used in the experiments. The groups are designated as follows: The initial letter, *T* or *D*, indicates the structural characteristics of the 3rd or terminal unit. *T* designates the *T*-unit, *D*, the diamond unit The second letter, *A* (the 1st unit) or *B* (the second unit) indicates the position of the *closed* diamond in the maze. The third letter, *L* or *R*, indicates the direction of the true-path in unit 3. The letter *F* in parenthesis, when it occurs, indicates a forced turn which does not involve an error. For example, in group *TBL(F)* the terminal or 3rd unit is a *T*-type unit, the closed diamond is in unit *B*, or the 2nd unit (the open diamond in *A*, or the 1st unit) and the group is forced left, in the 3rd unit, by a block at *y'*. If the letter *F* is *not* appended, the 3rd unit is an error-choice unit, the direction of the true-path being given by the letters *L* or *R*. Thus, for group *DAR*, the 3rd unit is a diamond unit, the closed diamond is in position *A* (the 1st unit), the open diamond is in *B* (the 2nd unit) The letter *R* indicates that the 3rd unit is an error-choice situation, the true path being to the right due to a block at *x* (see Figure) Groups *DA*, *DB*, *TA*, and *TB* are, of

TABLE 1
SCHEDULE OF GROUPS

	T groups										
	TA	TB	TAL(F)	TBL(F)	TAR(F)	TBR(F)	TAL	TAR	TBL	TBR	Total
♂	8	4	6	6	3	10					37
♀	4	8	4	4	7		5	5	5	5	47
Total	12	12	10	10	10	10	5	5	5	5	84

	D groups						
	DA	DB	DAL	DBL	DAR	DBR	Total
♀	10	10	5	5	5	5	40
						Total all groups	124

course, free-choice groups, the mazes used being indicated by the two letters

V. Procedure

Preliminary Training All animals were introduced gradually into a straightaway, and given two trials per day until habituated to the straightaway situation. Each animal was given a ration of modified Steenbock diet in individual food compartments at the end of the maze The animals received no food in the living cages The animals were given two mass runs in the experimental situation, to which they were assigned, as part of the preliminary training procedure. No records were taken of these two mass runs.

Experimental Procedure. One experimenter recorded the choices and paths of the animals while the other handled the animals Each animal received 20 grams of food per day in the individual food compartments at the end of the maze. The same order of running was maintained each day

VI Results

1. *The Initial Effect of the Structural Character of the Last Unit.* (Trials 1-20)

a The closed diamonds. Table 2 (Trials 1-20 inclusive) presents the average percentage of choices in the *closed* diamond which are in the same direction as the forced or correct turn in the last unit for all the forced-turn and error-choice groups. In the case of the free-choice groups (*TA, TB, DA,* and *DB*) data were obtained by computing the preference in the 3rd unit for each rat for trials 11-20 inclusive and this preference was arbitrarily defined as left or right depending upon which choices had the greater frequency for the 10 trials Then, the frequency of choices in the closed diamonds in the *same direction* as the 3rd unit preference, right or left, is expressed as a percentage of the total number of trials

To control the effect of right or left preferences which the rats may bring to the maze situation (i.e , inherent right- or left-going tendencies, etc) all of the groups, except the free-choice groups, were subdivided into two groups, in one of which the true path in the 3rd unit was to the right, and in the other to the left For example, *TBL* and *TBR* represent such a subdivision. Such groups have been combined in the analysis below

TABLE 2

PERCENTAGE OF TURNS IN THE CLOSED DIAMONDS IN THE SAME DIRECTION AS THE LAST UNIT TURN
Trials 1-20 and 22-30 inclusive

Groups	DAR-DAL	DA	TA	TAR-TAL	TAR(F)-TAL(F)
Trials 1-20 av.	75.00	71.11	53.75	41.50	37.00
σ 50%	3.54	3.59	3.23	3.54	2.50
50% + 2.50 σ	58.85	58.98	58.08	58.85	56.25
t	3.37	2.44	0.449	1.01	1.97
P	.01	.05	.7	.3	.05
After change					
Trials 22-30 av.	57.78	38.77	52.78	31.11	41.11
Diff.	17.22	32.34	0.97	10.39	4.11
t	1.39	2.35	0.091	1.41	0.465
P	.2	.05	.9	.2	.7

Groups	DBR-DBL	DB	TB	TBR-TBL	TBR(F)-TBL(F)
Trials 1-20 av.	85.00	59.00	63.68	45.00	54.25
σ 50%	3.54	3.54	3.23	3.54	2.50
50% + 2.50 σ	58.85	58.85	58.08	58.85	56.25
t	6.28	1.82	1.70	0.527	0.575
P	.01	.1	.1	.6	.6
After change					
Trials 22-30 av.	35.55	30.00	53.70	36.67	44.44
Diff.	49.45	29.00	9.98	8.33	9.81
t	3.43	4.24	1.42	0.892	0.852
P	.01	.01	.2	.9	.4

The first row of Table 2 gives the average percentage of turns in the same direction as the last unit turn-direction for trials 1-20. The second row gives the σ of chance.[8] The third row gives the percentages 2.50 σ from chance. In computing the standard errors by the *PQN* formula, *N* equals the total number of opportunities and *not* the number of animals. Any group in which the percentage of turns is *significantly greater than chance* ($50\% + 2.50\ \sigma$) indicates the significance for *this sample of trials* only and does not indicate that the *significance* of the obtained difference from 50% would be characteristic of a random sample of rats.

[8]The sigmas were computed by the formula $\sigma = \sqrt{\frac{PQ}{N}}$ where P = .5, Q = .5, and N = the total number of choices.

To overcome this limitation (for our data) of the *PQN* method of obtaining the significance of a difference, the statistics of the fourth and fifth rows were computed These statistics[4] (*t* and *P*) indicate the probabilities of the difference from chance being significant for a random sample Thus, the significance of the differences by this latter method overcomes the limitations of the *PQN* method These statistics (*t* and *P*) are applicable to our data because they were derived for use with samples of less than 30 cases The fifth row giving *P*, then, indicates the probability of the obtained difference occurring by chance in 100 *A P* of 05 or less indicates a significant difference.

Table 2, trials 1-20, indicates the effect of the 3rd unit, under varying conditions, upon the distribution of choices in the *closed* diamonds It will be seen that in *only one* of the T groups, group *TB*, is the percentage of turns in the *same* direction as the 3rd unit true-path greater than $50\% + 2.50\sigma$ As we shall show later, the percentage in group *TB* is spuriously raised by the chance selection of positional animals

The groups in which unit 3 is a diamond (the *D* groups) show *without exception* a significantly greater percentage of turns in the true-path direction of unit 3 than could obtain by chance. The probabilities that the obtained percentages are due to sampling errors are given in the row of *P* It will be seen that all the *D*-type group percentages, with the exception of group *DB*, are significantly different from chance. In the *T*-type groups the percentage of choices in the direction of the last unit turn are, without exception, not significant All of the probabilities are greater than 05 and indicate that the obtained percentages might have arisen through sampling errors The *TAR(F)-TAL(F)* group percentage is significantly different from 50% but the percentage indicates that the choices in the closed diamond are in disagreement with the last unit turn.

It will be noted that in the *D*-type groups the 3rd unit has the *same* structural characteristics as the preceding closed diamond of

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[4]The formulae used to obtain *t* are $\bar{x} = \frac{1}{n^1} \Sigma (x)$

$$\frac{S^2}{n^1} = \frac{1}{n(n-1)} \Sigma (x - \bar{x})^2 \quad t = \frac{x\sqrt{n^1}}{S}$$

From Fisher (5*a*, pp 104-107

the maze. In the *T* groups in which the 3rd unit is structurally *different* from the preceding closed diamond of the maze, the choice frequencies of the closed diamond can be accounted for by chance. This finding supports the "choice-point expectancy" hypothesis. We shall provisionally term choices or turns in the same direction as the last unit's true-path, "expectancy choices." The reason for thus terming this behavior at this point is solely to achieve brevity of exposition. Results given below, however, fully support our use of this term.

Table 3 presents the differences and the significances of the differences between groups.[5] The standard errors of the observed proportions are, of course, subject to the same limitations as the standard errors of 50% given in Table 2. The groups with the closed diamond in the *B* position are compared with each other, and likewise, the groups with the closed diamond in the *A* position are compared with each other. We see that the *TA* group shows a significantly higher frequency of expectancy choices than the *TAL(F)-TAR(F)* and *TAL-TAR* groups. The latter groups are forced-turn, and error-choice groups respectively. This finding may be explained by the fact that the free-choice group is free to exercise any initial positional preference in the maze. Such an expression of inherent preference would presumably result in a higher agreement between choices in choice situations than would obtain in a forced group. In the latter case some rats are undoubtedly forced against their innate preferences. The *TB* group has a significantly greater frequency of choice-direction agreements than the *TBL-TBR* groups.

The *D*-group comparisons indicate that when the last turn *is effective,* the effect is *increased* by making the last turn involve an error. The *DAL-DAR* and the *DBL-DBR* groups show a greater percentage of expectancy-choices in the closed diamond than do the *DA* and *DB* groups. The difference between the *DBL-DBR* and *DB* groups is 5.66 times the standard error of the difference.

Table 4 presents the differences between the *DA*-type groups and *TA*-type groups, and between the *DB*-type groups and the

[5]The standard errors of the observed proportions and the standard errors of the differences were computed by use of formula 106 ($\sigma = \sqrt{\frac{PQ}{N}}$, P=the proportion of expectancy choices and Q=proportion of non-expectancy choices) (Holzinger, 5*b*, pp. 248-250).

TABLE 3
COMPARISONS OF EXPECTANCY CHOICES IN THE CLOSED DIAMONDS
Trials 1-20 inclusive

Groups			TA	TAL-TAR	TAL(F)-TAR(F)
	Av		53.33	41.50	37.25
TA	53.33				
		Diff		11.83	16.08
		σ Diff		4.744	4.026
		C R		2.494	3.994
TAL-TAR	41.50				
		Diff			4.25
		σ Diff			4.240
		C R			1.002

Groups			TB	TBL-TBR	TBL(F)-TBR(F)
	Av.				
TB	63.34		63.34	44.50	54.25
		Diff		18.84	9.09
		σ Diff		4.693	3.985
		C R		4.014	2.281
TBL-TBR	44.50				
		Diff.			9.75
		σ Diff			4.307
		C R			2.264

Groups			DAL-DAR	DBL-DBR
	Av		74.50	84.00
DA	71.11			
		Diff.	3.39	
		σ Diff	4.573	
		C R	0.741	
DB	59.50			
		Diff		24.50
		σ Diff		4.332
		C R		5.656

TB-type groups Without exception the *DAL-DAR* and *DA* groups show a significantly greater frequency of expectancy-choices in the closed diamond than do any of the *TA*-type groups

The *DBL-DBR* group has a significantly greater frequency of expectancy-choices than any of the *TB*-type groups The *DB* group deviates from the expected result However, it is significantly greater than the *TBL-TBR* group. The percentage of expectancy-choices in group *DB* is lower than the percentage of group

TABLE 4
COMPARISONS BETWEEN T-TYPE AND D-TYPE GROUPS OF PERCENTAGE OF EXPECTANCY-CHOICES IN THE CLOSED DIAMOND
Trials 1-20 inclusive

Groups			TA	TAL-TAR	TAL(F)-TAR(F)
	Av		53 33	41 50	37 25
DA	71 11				
		Diff.	17 78	29 61	33.86
		σ Diff	4 667	4 853	4.155
		C R	3 810	6 101	8 149
DAL-DAR	74 50				
		Diff	21 17	33 00	37 25
		σ Diff.	4 458	4.652	3 917
		C R	4 749	7 094	9 510
Groups			**TB**	**TBL-TBR**	**TBL(F)-TBR(F)**
	Av				
DB	59.50		63 34	44 50	54.25
		Diff.	3 84	15 00	5 25
		σ Diff	4 660	4 940	4 272
		C.R	0 824	3 036	1.229
	Av				
DBL-DBR	84 00				
		Diff	20 66	39 50	29.75
		σ Diff	4 050	4 367	3 594
		C R	5 101	9.045	8.278

TB As pointed out above, however, the *TB* percentage is spuriously raised by positional preferences The difference between the *TBL(F)-TBR(F)* percentage and the *DB* percentage is in the expected direction but the difference is not reliable

Briefly summarizing this section, we have shown: (1) A necessary condition for expectancy behavior to arise is that the last unit must be structurally like the preceding units. (2) When structural similarity is present an error-choice situation is more effective than a free choice situation

b The initial effect of the structural characteristics of the last unit upon the open diamonds in the A or B positions. In order to analyze the last unit's effect upon the *open* diamond, the following procedure was employed When a rat's path in the *open* diamond, as recorded by tabulating the segments over which the rat passed, deviated to the left of the mid-line the rat was scored as having a left preference on that trial. Likewise, if the rat's

path deviated to the right of the mid-line he was scored as having a right preference on that trial

When the rat's path was through the center of the diamond, or if the left deviations equalled the right deviations the rat was scored as having a mid-path Such paths, in computing the percentage of expectancy choices, were scored as agreeing 50% of the time and disagreeing 50% of the time with the last unit's correct turn-direction Thus, for these middle-path trials the same number of disagreements as agreements were tabulated.[6]

TABLE 5

PERCENTAGE OF EXPECTANCY PATHS IN THE OPEN DIAMOND
Trials 1-20 and 22-30 inclusive

Groups	DAR-DAL	DA	TA	TAR-TAL	TAR(F)-TAL(F)
Trials 1-20 av	43.50	14.44	53.96	41.25	58.75
σ 50%	3.54	3.59	3.23	3.54	2.50
50% + 2.50 σ	58.85	58.98	58.08	58.85	56.25
t	0.501	0.407	0.333	0.923	1.04
P	6	7	7	4	3
After change					
Trials 22-30 av	51.67	38.27	62.04	36.67	59.72
Diff	8.17	6.17	8.08	4.58	0.972
t	1.85	1.22	1.53	0.953	0.118
P	1	2	2	4	9

Groups	DBR-DBL	DB	TB	TBR-TBL	TBR(F)-TBL(F)
Trials 1-20 av.	47.25	54.25	64.40	38.00	52.63
σ 50%	3.54	3.54	3.23	3.54	2.50
50% + 2.50 σ	58.85	58.85	58.08	58.85	56.25
t	0.240	0.428	1.48	1.40	0.302
P	8	7	2	2	8
After Change					
Trials 22-30 av	49.99	54.44	52.31	49.44	48.33
Diff	2.74	0.195	12.09	11.44	4.29
t	0.696	0.01	1.22	1.55	0.329
P	5	9	.2	2	7

[6]*It may be suggested that the mid-path trials should have been excluded* Doing so would have decreased N and therefore the statistical reliability of the data The method used here increases the path-preference reliability and if we do not find significant results for the *open* diamond with the mid-path cases included we can be *certain* they would not be significant if the mid-path cases had been excluded

Table 5 presents the percentages of expectancy paths[7] in the *open* diamonds for the first twenty trials Groups $TAL(F)$-$TAR(F)$ and TB show a significantly greater number of expectancy paths than can be accounted for by chance alone ($50\% + 2.50\ \sigma$) As we shall show in the next section this agreement cannot be due to expectation of the last correct turn In all the other groups, both the T type and the D type, the percentages are not significantly greater than could obtain by chance. However, when we employ Fisher's method of analysis, (i e., using T and P) we see that *none* of the percentages of expectancy paths in the open diamond are significantly different from 50%.

2. *The Effect of Reversing the Direction of the Last Correct Turn* (Trials 22-30 inclusive.)

On trial 21 the direction of the last correct turn was reversed for all groups except the free-choice groups (TA, TB, DA, and DB) In these latter groups each rat was forced opposite his established preference. It will be remembered that a rat in the free-choice groups is arbitrarily assumed to have a right or left preference according to which choice-direction has the greatest frequency in the 3rd unit for trials 11-20 inclusive.

Since the last correct turn is now *opposite* to the turn-direction used in the analysis of the first 20 days a *decrease* in percentages indicates an increased *agreement* of the A or B unit choices with the last correct turn-direction of the first twenty trials This is so because we are continuing to tabulate the choices in units A and B as agreeing or disagreeing with the unit 3 correct turn-direction of the first twenty trials

Table 2 presents the percentage of expectancy-choices in the *closed* diamonds for trials 22-30 inclusive The differences between trials 1-20 and 22-30 (i e, before and after the reversal of the correct last turn-direction) are also given

The most conclusive evidence of the effectiveness of the last correct turn in varying the distribution of choices in the *closed* diamonds is obtained by the reversal of the last correct turn-direction If the choices in the closed diamonds reverse their direction to conform

[7]The open diamond, of course, does not involve a choice in the sense of choosing which of two alleys to enter, but it does allow the animal to express a preference for one or the other side of the alley, or no preference (middle path) In this sense it is a choice of one path among many possible paths

to the new last correct turn-direction, then we may conclude that the last correct turn is the effective variable

Table 2 indicates that the above conditions are met only by the *D*-type groups. The *T*-type groups in which the last unit is structurally dissimilar to the preceding units show *no* significant change The *D*-type group differences with the exception of group *DAR-DAL* are all significant The *P*'s for the *T*-type group differences are all either .2 or greater.[8]

Since the *TB* group shows no significant change, the high frequency of expectancy-choices for trials 1-20 can only be due to a chance selection of positional animals Therefore, the previous disparities of results noted for this group may be attributed to selection

The *DAR-DAL* group does not show, as has been indicated, a significant change when the direction of the last correct turn was reversed. This discrepant result may, it is suggested, be due to "fixation" (persistence) of the last correct turn-direction The closed diamond for this group is in the first unit and the reward value of the last turn is presumably less effective than in those groups in which the closed diamond is in the B position (2nd unit). The *DB* and *DBL-DBR* groups reverse their expectancy-choices in the closed diamond to a more significant extent than the *DA* and *DAR-DAL* groups In the former groups the closed diamond is nearer the last correct turn and reward than in the latter groups. Consequently, if expectancy-behavior is conditioned by the reward value of the last turn, we should expect these groups quickly to reverse their behavior. In the *DAR-DAL* and *DA* groups an expectancy-choice in the closed diamond is not so immediately followed by reward. Hence, the choices of the rats in these groups would not so quickly reverse their direction to conform to the new last turn-direction This suggests that the degree of persistence in an act, after the act has been made inconsistent, is dependent upon the reward value attached to the act

Table 5 shows the effect of the last correct turn-direction reversal upon the *open* diamond No group shows a significant change between trials 1-20 and 22-30. Thus, we again see that the distribution of right or left path deviations in the open diamond, which is structurally different from both the *T*-type and *D*-type terminal units, is *not* a function of the last unit's correct turn-direction

[8]Fisher's method for determining the significance of the mean of a unique sample takes account of the possible correlation between the two variables

3 *The Effect of Proximity upon the Distribution of Expectancy Choices*

a. The closed diamonds. A comparison of the closed-diamond expectancy-choice frequencies for the first twenty trials (Table 6) indicates that no marked effect can be attributed to proximity In only one comparison in Table 6, that between $TAL(F)$-$TAR(F)$ and $TBL(F)$-$TBR(F)$, is the difference significant Furthermore, this difference is due to the disagreement of $TAL(F)$-$TAR(F)$ and is not due to a statistically significant percentage of expectancy-choices in group $TBL(F)$-$TBR(F)$

However, inspection of Table 6 reveals that proximity may have a slight effect In all of the inter-comparisons, with the exception of the DA and DB comparison, the groups with the closed diamond in the B position (2nd unit) display a greater percentage of expectancy-choices than the groups with the closed diamond in the A position (1st unit). As was pointed out above, the critical ratios with one exception are less than 2.5.

TABLE 6
DIFFERENCES BETWEEN PERCENTAGE OF EXPECTANCY CHOICES IN THE CLOSED DIAMONDS IN A & B POSITIONS
Trials 1-20

Groups			*DBR-DBL*	*DB*
	Av		84 00	59 50
DAR-DAL	74 50	Diff	9 50	
		σ Diff	4.027	
		C R	2 359	
DA	71 11	Diff		11 61
		σ Diff		4 844
		C R		2 397

Groups			TBR-TBL	TBL(F)-TBR(F)	TB
	Av		44 50	54 25	63 34
TAR-TAL	41 50	Diff	3 00		
		σ Diff.	4 949		
		C R	0 606		
TAL(F)-TAR(F)	37 25	Diff		17 00	
		σ Diff		3.471	
		C R		4 898	
TA	53 33	Diff			10 01
		σ Diff.			4 478
		C R			2 235

On trial 31, the positions of the open and closed diamonds were interchanged for each group. This, of course, changes the proximity variable which we are here considering.

Table 7 gives the percentages of expectancy choices in the closed diamonds for trials 22-30 and for trials 31-35, and the differences and the significance of the differences.

It is apparent at once that *only* the *DAL-DAR* and *DA* groups show a significant change due to placing the closed diamond *nearer* to the last unit. In the *DBR-DBL* and *DB* groups the closed diamond is placed farther from the last unit for trials 31-35. No significant change results, though the percentage of expectancy-choices continues to increase. (A decrease in actual percentages; see above.) The continuous increase in expectancy-choices for both the *DAR-DAL, DA* and the *DBR-DBL* and *DB* groups argues that learning is still taking place. The continuous increase in expectancy-choices as shown by a trial-by-trial analysis is not presented here. However, the significantly greater increase in the *DAR-DAL* and *DA* groups may be due to the increased proximity of the closed diamond to the last unit.

The latter finding is consistent with the results of the first twenty trials where a slight but not significant difference due to proximity

TABLE 7

EFFECT OF THE CHANGE IN THE POSITION OF THE CLOSED DIAMOND UPON THE PERCENTAGE OF EXPECTANCY CHOICES

Trials 22-30 and 31-35 inclusive

Groups	DAR-DAL	DA	TA	TAR-TAL	TAR(F)-TAL(F)
Trials 22-30 av	53 09*	30 16*	52 78	31 11	41 11
Trials 31-35 av	6 67	5 71	58 33	25 33	34 00
Diff	46 42	24 44	5 56	5 78	7 11
t	4 06	2.41	0 552	0 510	0 078
P	01	.05	6	6	9
Groups	**DBR-DBL**	**DB**	**TB**	**TBR-TBL**	**TBR(F)-TBL(F)**
Trials 22-30 av	35 55	30 00	53 70	36.67	44 44
Trials 31-35 av	24 00	20 00	63 33	40.00	47 00
Diff	11 55	10 00	9 63	3.33	2 56
t	0 645	0 988	1.59	0 237	0 248
P	5	3	.1	8	8

*These averages are different from those given in tables elsewhere. This is due to having used a different N.

appeared. It is possible that the *change* of the position of the diamonds emphasizes the linear characteristics of the maze in such a manner that the rat may be more easily influenced by the expectancy factor as it approaches the end of the maze.

Proximity of the open diamond to the last unit has (as would be expected from its previous chance agreement) *no* effect upon the percentages of expectancy "choices" This is shown in Table 8 where the differences between trials 22-30 and 31-35 and the significances of these differences are given.

It may be interesting to give here the percentage of agreement between the 1st and 2nd, 1st and 3rd, and the 2nd and 3rd units It will be remembered that in the analysis above the free-choice groups have their percentages of choice-direction agreements with the last unit based upon an arbitrary criterion of preference, namely, the frequency of right or left choices in the 3rd unit for trials 11-20 inclusive. In Table 9 the percentages of agreement are based upon the actual choices for each trial. Thus, for the free-choice groups we can show whether or not a right or left preference in unit 3 for a given trial will result in right or left preferences in the preceding units for that trial or *vice-versa* The forced-turn and error-choice

TABLE 8

EFFECT OF CHANGE IN THE POSITION OF THE OPEN DIAMOND UPON THE PERCENTAGE OF EXPECTANCY PATHS
Trials 22-30 and 31-35 inclusive

Groups	DAR-DAL	DA	TA	TAR-TAL	TAR(F)-TAL(F)
Trials 22-30 av	53.70*	24.60*	62.04	36.67	59.72
Trials 31-35 av.	46.67	31.43	61.67	39.00	59.00
Diff	7.03	6.83	0.37	2.33	0.72
t	1.24	1.05	0.066	0.525	0.084
P	.3	.3	.9	.6	.9

Groups	DBR-DBL	DB	TB	TBR-TBL	TBR(F)-TBL(F)
Trials 22-30 av	49.99	54.44	52.31	49.44	48.33
Trials 31-35 av	50.00	53.00	58.33	37.00	48.00
Diff	0.01	1.44	6.02	12.44	0.33
t	0.00	0.154	0.582	0.662	0.025
P	1.0	.9	.6	.5	.9

*These averages are different from those given in tables elsewhere This is due to having used a different N

TABLE 9
PERCENTAGES OF CHOICE AGREEMENTS BETWEEN ALL UNITS
Trials 1-20

Units	DAL-DAR	DA	TA	TAL-TAR	TAL(F)-TAR(F)
1-2 Av	43 75	51 03	48.10	54 75	59 00
1-3 Av	75 00	72 16	52 10	41 50	37 00
2-3 Av	42 75	50 00	55 20	41 25	58 75
σ 50%	3 54	3 59	3 23	3 54	2 50
50% $\pm$ 2 50 σ	58 85	58.98	58.08	58 85	56 25
Units	**DBL-DBR**	**DB**	**TB**	**TBL-TBR**	**TBL(F)-TBR(F)**
1-2 Av	46 75	48 75	61 25	58 00	52.13
1-3 Av	47 25	47 25	63 13	38 00	52 63
2-3 Av.	84 00	54 50	65 40	45 00	54 25
σ 50%	3 54	3 54	3 23	3 54	2 50
50% + 250 σ	58 85	58 85	58 08	58 85	56 25

groups have their percentages of agreement based upon the *correct* turn direction for all comparisons with the 3rd unit

Table 9 gives the percentages of agreement between units for trials 1-20 With the exception of the *DB* group, all the groups in which the 3rd unit is a *diamond* show a significant relationship between the 3rd unit choices and the closed-diamond choices The *TB* group again shows the effect of selection, all agreements between units being significant The agreements between units *A* and *B*, and *B* and the terminal unit for group *TAL(F)-TAR(F)*, are also significant, but as *TBL(F)-TBR(F)* does not show this relationship, and *both* groups are not significantly changed by the reversal of the last turn-direction for trials 22-30, it is likely that the agreement is due to selection

This analysis indicates that our criterion of preference for the free-choice groups did not obscure the results.

VII. CONCLUSIONS

The purpose of the above series of experiments has been to determine under what conditions the last turn determines the distribution of choices in preceding units of a maze. We have found in answer to the questions originally posed, that.

1 A forced turn followed by food in a unit *structurally dissimilar* (*T*-unit) to the other maze units is *not* an adequate condition to affect the distribution of choices in the preceding units.

2. When the rat determines its own preference for the direction of its turn in the last unit, and this unit (T-unit) is structurally *different* from the preceding units, the last unit's turn-direction is *not* effective in determining the choices of the preceding units

3. A last turn involving an error in a unit structurally *different* from the preceding units does *not* significantly affect the choices in the preceding units.

4. When the rat determines its own turn-preference in the last unit, and this unit (D-unit) is structurally *similar* to a preceding unit, the last turn is effective in determining the choices of the preceding similar unit

5. When the last unit is similar to a preceding unit, a last turn involving an error is *more* effective in determining the choice in the preceding similar unit than any of the other conditions here investigated.

6 Dissimilar choice-units, and units not involving a choice but allowing deviations which may express a right or left preference (also dissimilar to the last unit) show *no* relationship in terms of choices and path deviations with the last turn-direction

7. The proximity of the similar units within the first twenty trials is effective but not significantly so

8 A change *increasing* the proximity of the similar unit to the last unit does, it would seem, significantly increase the percentage of choice agreements of the similar preceding units with the last turn

VIII. Discussion

In the experiments above, those units which are similar to the last unit before food seem to release an expectation that such and such a turn or choice will lead to food The specific intra-maze stimuli apparently are not effective in releasing these choice-point expectancies within the limits of the experiments reported here. The general maze structure or form is the effective variable. In the last unit the rat builds up expectancies as a result of stimuli and what follows from them when he behaves. And then, insofar as the stimuli presented by the previous units cannot be discriminated by the rat from those presented by the last unit, he tends to expect the same behavior supports (13) at these other choice-points. In other words the animal builds up behavior-support expectancies which are carried over from the last unit to preceding units if the units present similar

structural stimuli.[9] Units dissimilar to the last unit are not stimuli for the expectation that a turn left or right will lead to food.

It would seem that, if the above remarks are correct, the goal-gradient hypothesis insofar as it involves error scores will have to be modified. Only under certain conditions will the errors progressively decrease as the end of the maze is approached. They will increase or decrease as the various choice-points are similar enough to the last one to release or fail to release expectations that such a choice will lead to food, or the correct path to food. In a non-linear maze, or a maze with dissimilar units, we should expect the goal-gradient variable to be affected by the degree of similarity of units, or other features of the maze that might possibly influence the identical characteristics of the units.

The results reported here would seem to indicate also that the last unit must involve a problem to be effective. It must be a choice of some sort. A turn alone varies the structure of the last unit so that it cannot be identical with preceding choice units. A turn alone may be effective when, as shown by Yoshioka (14), the continuation of the path after the turn is long enough, or so placed as to emphasize the spatial direction of the food. However, that the last unit involves a problem is not enough to affect the choice in preceding units. The units must be structurally similar. If the last unit involves an error in the choice, thus emphasizing the problem *characteristics of the choice (as compared with a free choice)*, a greater effect in the choices of preceding similar choice-points results. Extreme punishment for the error might possibly overcome, within limits, the negative effect of dissimilar choice-points.

We are now in a position to examine critically the choice-point expectancy hypothesis with respect to the above results and the theories given at the beginning of this paper. Hunter (6) regards the behavior phenomenon as "an earlier and earlier appearance in the total behavior of that *type* of response which leads immediately to food and exit." We have shown that *only* when choice situations are similar could this statement be true, and that while the response, such as a turn, might well be similar to *turns* in preceding units, *only* those turns conditioned upon a similar environment and involving a choice are effective. Further, this statement does not indicate

[9] The writers are indebted to Professor E. C. Tolman for suggesting this interpretation.

the causal conditions of the behavior. The second theory of "anticipation" is based upon the *turn* We have indicated that a *turn* as such cannot be effective The essential conditions for the occurrence of the behavior are *choice situations of similar structural characteristics*

The choice-point expectancy hypothesis emphasizes similarity of units, and holds that such units will release the expectation of a reward until the discreteness of the preceding units is learned When the linear placements or differences between units are learned, the similarity of supports disappears. Thus, less and less expectancy-choices would be made if the animal were punished for incorrect responses (making an error) as is the case in the usual maze

We therefore submit the choice-point expectancy hypothesis as a useful explanation of the behavior investigated here

IX Summary

Ten groups, totalling 124 rats, were run in maze situations designed to determine the nature and effect of the last correct choice before food upon the preceding maze choices It was found that for the last correct choice-direction to be effective in determining the choices in preceding units, the units must be structurally similar. Under the latter conditions, a free-choice situation in the last maze unit is less effective than an error-choice situation

Proximity of the identical unit to the last unit was not found to be a statistically significant variable in the first 20 trials. But an increase in proximity, after the first 20 trials, resulted in a significantly increased effect of the last turn-direction upon the distribution of choices in the similar unit

These results substantiate the theoretical concept of choice-point expectancy They also indicate that the goal-gradient hypothesis may have a more limited predictive value than was heretofore thought.

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L'EXPECTATION CHOIX-POINT DANS LE PARCOURS DU LABYRINTHE PAR LE RAT

(Résumé)

Pour déterminer les conditions dans lesquelles le dernier choix correct de direction dans un labyrinthe linéaire est efficace dans la détermination des choix dans les parties précédentes, on a fait parcourir un labyrinthe linéaire de trois parties à dix groupes, 124 rats en total Pour divers groupes, on a fait la structure de la dernière partie et semblable et dissemblable aux parties précédentes Pour que le dernier choix juste de direction soit efficace dans la détermination des choix dans les parties précédentes, il faut que les parties soient de structure semblable. Dans ces conditions une situation erreur-choix dans la dernière partie a été plus efficace qu'une situation choix-libre Quand la dernière partie a été dissemblable en structure aux parties précédentes, ni un tournant forcé, ni une situation choix-erreur, ni choix-libre dans la dernière partie n'ont été efficaces dans la détermination des choix dans les parties précédentes La proximité d'une partie semblable à la dernière partie n'a pas été un variable signifiant dans les 30 premières épreuves Une plus grande proximité, après les 30

premières épreuves, a donné comme résultat un effet augmenté d'une façon significative de la dernière direction du tournant sur la distribution des choix dans la partie semblable Ces résultats soutiennent les conceptes des "soutiens du comportement" (Tolman) et de l'expectation choix-point (Buel) Ils indiquent aussi que l'hypothèse de la gradation du but peut avoir une valeur prédictive plus limitée que celle supposée jusqu'ici

Buel et Ballachey

DIE WAHL-PUNKT-ERWARTUNG BEIM LABYRINTHLAUFEN DER RATTE

(Referat)

Um die Umstande festzustellen, unter denen die letzte richtige Richtungswahl in einem Linearlabyrinth wirksam ist, wurden zehn Gruppen von Ratten (mit einer Gesamtzahl von 124 Ratten) in einem dreifachen Linearlabyrinth untersucht. Der Bau der letzten Abteilung wurde fur die verschiedenen Gruppen den vorangehenden Abteilungen ahnlich oder unahnlich gemacht. Damit die letzte richtige Wahlrichtung wirksam bei der Bestimmung der Wahlen in den vorangehenden Abteilungen des Labyrinthes sei, mussen die Abteilungen baulich ahnlich sein Unter den letzten Umstanden war eine Fehler-Wahl-Situation (error-choice situation) in der letzten Abteilung wirksamer als eine freie Wahlsituation (free-choice situation) Wenn die letzte Abteilung den vorangehenden Abteilungen baulich unahnlich war, war weder eine gezwungene Biegung noch eine Fehler-Wahl noch eine freie Wahlsituation in der letzten Abteilung wirksam bei der Bestimmung der Wahlen in den vorangehenden Abteilungen Die Nachbarschaft einer Abteilung, die der letzten Abteilung ahnlich ist, war nicht eine bedeutsame Variante in den ersten 30 Proben Das Vergrossern der Nachbarschaft nach den ersten 30 Proben hatte eine deutlich vergrosserte Wirkung der letzten Biegungsrichtung auf die Verteilung der Wahlen in der ahnlichen Abteilung zur Folge Diese Ergebnisse bestatigen die Begriffe von "Verhaltungsstutzen" ("behavior supports") (Tolman) und Wahl-Punkt-Erwartung (choice-point expectancy) (Buel). Sie zeigen auch, dass die Ziel-Gradiententheorie einen beschrankteren Voraussagungswert haben dürfte, als bisher geglaubt wurde

Buel und Ballachey

AN ATTEMPT TO MODIFY THE EMOTIONAL ATTITUDES OF INFANTS BY THE CONDITIONED RESPONSE TECHNIQUE*[1]

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THE PROBLEM

This experiment has been devised to discover how the original behavior of infants to objects having no inherent biological significance might be affected through the repeated simultaneous presentation of other stimuli, markedly unpleasant or pleasant in character, and producing corresponding overt emotional changes; furthermore, whether, if any consistent change in behavior or attitude to the original series of neutral objects occurred which might be attributed to such coincident experience, the modification would be carried over to other objects, resembling but not identical with, the original series.

Briefly, the subjects were presented with a series of objects—a wooden triangle, rectangle, ring, cloth curtain, colored black and white, or grey or yellow—without intrinsic significance or interest other than as any object may be of interest to grasp or manipulate to an infant. At intervals during the repeated presentation of certain of these objects an electric bell was rung, the sound constituting a startle stimulus; coincidentally with others a toy was placed before the child, and at intervals, a short melody played on a music box The disagreeable and agreeable stimuli alternated with each other, much as unpleasant and pleasant experiences follow each other in the ordinary course of a child's day, as when a child's nose is cleaned with a cotton swab and it is later picked up or fed or played with.

Before and after this training and at regular intervals during training each object was presented alone The problem was whether, under the conditions of the experiment, the responses which were

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consequent upon the startling ring of the bell or the presentation of the toy and melody would become attached, through repeated simultaneous experience, to the neutral stimuli, the geometrical forms and the curtains; or whether the original responses to the neutral stimuli would be consistently modified in any way corresponding to the character of the responses to the simultaneously experienced emotionally charged stimuli; and finally, whether such changes, if they occurred, would tend to persist in response to objects similar to but not identical with those used during the training

The experiment is thus one in learning under conditions arranged after the conventional C-R pattern. Other investigators have reported changes in the overt behavior of infants under similar conditions (1, 2). We are unaware, however, of any study of one or more children which has employed agreeable as well as disagreeable conditioning stimuli in otherwise equivalent situations, and has thus provided a control by means of which changes in behavior following association with either kind of stimuli might be checked

THE SUBJECTS

The subjects, 15 in number, were infants committed to the permanent care of an infants' home in New York City, because of the death, destitution, incompetence, or neglect of their natural guardians[2] Seven boys and eight girls, they included two of 8 mos, two of 11 mos, six of 12 mos, one of 13 mos, two of 14 mos, and one each of 15 and 16 months, at the time experimental work with each child was begun. The median age was twelve months. The children were all in good physical condition and adjusted to the institution, in whose care they had been either from soon after birth, or for some months prior to the time of the beginning of the experiment.

Infants committed to institutional care are not, of course, a random sample of the total infant population We therefore selected for study the babies who were apparently the most alert of those available in the age range desired. Superficially, all except two, as

[2]The Home for Hebrew Infants. We are greatly indebted to the late Dr Alfred H Hess, Chief of its Medical Board, and the superintendents, Miss Crowley and Miss Creed, for the privilege of working at the institution; and to the nursing staff for unfailing courtesy and help during the course of the investigation.

they were observed during the experiments, seemed to be developing normally. These two proved to be apathetic and dull

All fifteen subjects were the children of Hebrew mothers, nine also of Hebrew fathers; three were the offspring of mixed marriages, of three the paternity is unknown. Occupations of the fathers, where known, were as follows two salesmen, a printer, a printer's helper, an accountant, a tailor, two auto mechanics, one garage worker. Of four mothers who were employed, three were sales-clerks, one a clerical worker Nine children had been born out of wedlock.

The Materials

The disagreeable or startle stimulus was an electric iron box cow-bell, Stanley and Patterson Catalogue No 215 PR, wired in series to two dry cells, and to a push button operated by foot pressure. The bell was mounted on a small board 3" x 6" to which was attached a hook by means of which the bell could be hung on the back of the child's chair The sound thus proceeded from directly and close behind the child's back, midway between the shoulders and waist. It was rung always for one second, stopwatch timing This stimulus will hereafter be called S

There were two agreeable stimuli, a small red celluloid rattle in the shape of a dumb-bell—two celluloid balls connected by a short cylindrical length of white rubber—and the melody, 10" in duration, "Two Sunny Little Blue Birds" produced by a Swiss music-box The rattle will henceforth be called R1, the music R2.

The neutral stimuli, with which S or R1 and R2 were associated, were six in number, three pairs of objects The members of each pair were roughly equivalent in general character, but easily to be distinguished from each other. One member of each pair was associated only with S, the other only with R1 R2. We shall call these St1 to St6

St1 was a rectangular block made of wood 12" x 2" x 1"; St2 a wooden equilateral triangle formed of a cylindrical core 1" in diameter, 7" on a side, St3 a cloth curtain 14 inches square. All three objects were checkered black and white, and were associated only with S, the startle stimulus St4 was a rectangular flat of wood, 6" x 4" x 1", painted gold, St5 a wooden ring, diameter 6 inches, core 1 inch, painted grey; St6 a yellow curtain 14 inches square St4, 5, and 6 were presented only in conjunction with R1 R2, the toy and melody

For each member of this major series of neutral stimuli, St1 to St6, there were several derivative forms of identical shape and material, but differing in either size or color, to which it was our intention to observe the possible transfer or generalization of the effect of S and R1 R2. These objects were presented to the child only before the beginning and after the completion of training The full series of major and derivative neutral stimuli with their symbols and precise specifications are listed below

The Plan of the Experiment

The first two days of experiment with each child were spent in obtaining its initial responses to St1 to St6, and their derivative forms One St after another was placed directly before the child, within reach, for a period of 90 seconds each During these sessions the reactions to S, R1, and R2 were also ascertained. S was sounded four times during each session R1 was presented twice for periods of 90 seconds each, and R2 played twice during each presentation of R1 Subjects who did not respond to S by startle reactions were not used for further experiment[8]

On the third experimental day, St1 to St6 only were presented, always for 90 seconds, in the order 1, 4, 2, 5, 3, 6 S was sounded at intervals during the exposure of St1, 2, and 3; four times during the presentation of each object. R1 was placed before the child throughout each 90-second period during which St4, 5 and 6 were presented, R2 was played twice during each such period

On the fourth and fifth days St1 to 6 were each first presented alone for 90 seconds, then accompanied by the conditioning stimuli as noted in the preceding paragraph. In order that the training periods should not fatigue the subject unduly, St1, 4, 2 and 5 only were presented on the fourth day, St3 and 6 on the fifth On these days, St1, 3 and 5 were also presented without the bell (S), after each conditioning period, as well as before. The effect of the training during the third, fourth, and fifth days was tested on the sixth day by giving St1 to St6 alone. The exact layout for each day is shown below.

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[8]Only four subjects out of twenty-three to whom S was administered under the conditions of the experiment failed to give responses indicating startle

DESCRIPTION OF NEUTRAL STIMULI

Symbol	Description	Size in in	Color
St1	rectangular block of white wood	12x2x1	checkered in black and white 1" squares
11	rectangular block of white wood	6x1x½	checkered in black and white ½" squares
14	rectangular block of white wood	18x3x1½	checkered in black and white 1½" squares
12	rectangular block of white wood	12x2x1	grey
13	rectangular block of white wood	12x2x1	black and white longitudinal stripes 1"
St2	equilateral triangle, cylindrical sides, of white wood*	7" core 1"	checkered in black and white squares 13/16"
21	equilateral triangle, cylindrical sides, of white wood*	3⅛" ½"	checkered in black and white squares 1¼"
24	equilateral triangle, cylindrical sides, of white wood*	9½" 1½"	checkered in black and white squares 5/16"
22	equilateral triangle, cylindrical sides, of white wood*	7" 1"	grey
23	equilateral triangle, cylindrical sides, of white wood*	7" 1"	black and white longitudinal stripes 13/16"
St3	curtain of permatex cloth	14x14	checkered in black and white 2" squares
31	curtain of permatex cloth	10½x10½	checkered in black and white 1½" squares
32	curtain of permatex cloth	21x21	checkered in black and white 3" squares
St4	rectangular flat of white wood	6x4x1	gold
41	rectangular flat of white wood	3x2x½	gold
44	rectangular flat of white wood	9x6x2	gold
St5	ring of white wood	diam 6" core 1"	grey
51	ring of white wood	diam 3" core ½"	grey
54	ring of white wood	diam 9" core 1½"	grey
St6	curtain of permatex cloth	14x14	yellow
61	curtain of permatex cloth	10x10	yellow
62	curtain of permatex cloth	21x21	yellow

*It was intended that these should be 6¼" on a side, the perimeter approximately equal to the circumference of the wooden ring St5 In turning the triangles, the carpenter, in error, made them slightly larger than specified

PLAN OF EXPERIMENTS

	Schedule	Stimulus	Period	
First experimental day	A	St 1	90″	
		4	"	
		2	"	
		5	"	
		3	"	
		6	"	
		S for 1″	"	at 15″ and 60″
		R1 + R2	"	R1 continuous R2 at 25″ and 70″
		Rest*	180″	
	A1	St 11	90″	
		41	"	
		21	"	
		51	"	
		31	"	
		61	"	
		S for 1″	"	at 15″ and 60″
		R1 + R2	"	R1 continuous R2 at 25″ and 70″
Second experimental day	B	St 12	90″	
		22	"	
		32	"	
		62	"	
		S for 1″	"	at 15″ and 60″
		R1 + R2	"	R1 continuous R2 at 25″ and 70″
		Rest	180″	
	B1	St 13	90″	
		23	"	
		14	"	
		44	"	
		24	"	
		54	"	
		S for 1″	"	at 15″ and 60″
		R1 + R2	"	R1 continuous R2 at 25″ and 70″
Third experimental day	C	St1 and S	90″	S at 15″ 35″ 55″ 75″
		Rest	90″	
		St4 + R1R2	90″	R1 continuous R2 at 25″ and 70″
		Rest	90″	
		St2 and S	90″	S at 15″ 35″ 55″ 75″
		Rest	90″	

*During the rest periods it was found advisable to give the children something to play with Small wood blocks or sugar pellets were most often used These interested and amused the children yet were small enough to be easily removed and without disturbance when the rest period was up

PLAN OF EXPERIMENTS

	Schedule	Stimulus	Period	
		St5 + R1R2	90″	R1 continuous R2 at 25″ and 70″
		Rest		
		St3 and S	90″	S at 15″ 35″ 55″ 75″
		Rest	90″	
		St6 + R1R2	90″	R1 continuous R2 at 25″ and 70″
Fourth experimental day	D1	St1	90″	
		St1 and S	90″	S at 15″ 35″ 55″ 75″
		Rest	180″	
		St1	90″	
		Rest	90″	
		St4	90″	
		St4 + R1R2	90″	R1 continuous R2 at 25″ and 70″
		Rest	180″	
		St2	90″	
		St2 and S	90″	S at 15″ 35″ 55″ 75″
		Rest	180″	
		St2	90″	
		Rest	90″	
		St5	90″	
		St5 + R1R2	90″	R1 continuous R2 at 25″ and 70″
Fifth experimental day*	D2	St3	90″	
		St3 and S	90″	S at 15″ 35″ 55″ 75″
		Rest	180″	
		St3	90″	
		Rest	90″	
		St6	90″	
		St6 + R1R2	90″	R1 continuous R2 at 25″ and 70″
Sixth experimental day	E	St1	90″	
		Rest	90″	
		St4	90″	
		Rest	90″	
		St2	90″	
		Rest	90″	
		St5	90″	
		Rest	90″	
		St3	90″	
		Rest	90″	
		St6	90″	
		Rest	90″	

*Occasionally D and D2 were given on the same day with a rest period between This was done when the child showed no fatigue and postponement of D2 to the following day would have made necessary an interval of more than 24 hours between D2 and the test period E which followed it

At this point, if training was to be continued, Schedules C, D1, D2, and E were repeated in turn on successive days as often as desired Schedules in the second cycle of training were designated 2C, 2D1, in the third cycle 3C, 3D1, etc. On the final round or cycle of training A1, without S or R1 R2, followed E after a rest period of 180 seconds. Schedules B and B1 were given on the following day, again without S or R1 R2. We have called these schedules tA1 and tBtB1, respectively If no further training was to be given tA1 followed directly upon the schedule E, allowing a rest period of 180 seconds, Schedule tBtB1 on the succeeding day Thus Schedules A-A1, B-B1, and Schedules E, tA1, tB, tB1 represent test periods before and after training, respectively, and Schedules C, D1 and D2, 2C, etc, intermediate training periods.

The experiments were carried out between the hours of 2 P M and 4 P M., at intervals of twenty-four hours, except when visiting days at the institution or other circumstances made longer intervals between training periods unavoidable. In no case, however, did more than twenty-four hours elapse between a test period E, or E and tA1 (forty-eight hours for tBtB1) and the last training period preceding it

Of the group of fifteen babies, eleven were carried through two complete cycles of training, one child was carried through four cycles, one through three, and two through one cycle. Of these last two, one child was ill on the day on which the second cycle of training was to be begun and had to be transferred to the infirmary The second child, subject B M, developed complete adaptation to S during the second cycle of training and the experiment was discontinued.

Experimental Set-Up

The experiments were carried out in a small room on the second floor of the institution The children were always carried to the room and returned again to their own cribs by the experimenter The child was seated during the experimental periods in a small adjustable chair built after the model described by Gesell, with canvas seat and back. This was set on a table platform 26″ x 40″ and 32″ high The window which lighted the room was to the child's back To his right and directly in front, at the side and end of the platform, were the cream-colored walls of the room

On the platform directly before the child was set a small table

12" x 20", and 10" high, on which the experimental objects were placed one by one by the experimenter, who stood at one side of the platform, to the left and slightly in front of the child This table was an ordinary bed-tray with legs lengthened to be of a suitable height. It was cork covered so as to deaden the sound of objects accidentally or purposely dropped or banged by the subject, since we found the noise of such dropping likely to constitute a startle stimulus.

Two brass flanges were fastened to the table top, midway along the right and left hand edges Into each of these was screwed a brass upright 21½" high, carrying screw eyes at the top and 4½" from the top From the lower ones the curtains, St3, 31, 6, and 61, and from the upper St62 and 32 were hung when needed, by means of brass snapper clips which were attached to the upper two corners of each curtain (A thin strip of wood, like that found in the hem of ordinary window shades, was run through the hem of each curtain, to give it rigidity and keep it in shape)

The experimental materials were kept, during the experiment, on a low table to the experimenter's left and were out of sight of the subject when not in use The electric bell S, as noted before, was hung on the back of the child's chair, on a brass band which braced the two wooden uprights forming the back frame of the chair Thus the sound proceeded from a distance of only about an inch behind the child, through the thickness of the canvas which formed the back and seat of the chair, and at a point approximately half way between the child's shoulders and waist The source of the sound was therefore invisible to the child, as were, of course, the wiring and the push button by which the bell was activated and which was under the experimenter's left foot

Recording the Responses

The experimenter and the subject were alone in the room throughout the course of the experiments The child, comfortably seated in the chair, was free to make any response in his repertoire which the stimulus immediately before him or the total situation—the attendant circumstances of the experiment—might call forth

The responses, as they occurred, were recorded by the experimenter, without, at the time, either interpretation or evaluation Every overt response made by the child during the experimental

period was set down, by means of a fairly simple code which provided for all the possible responses relevant to the experiment, and which permitted their recording almost as soon as they took place[1] Blank forms ruled in cross-section were used for the records, so laid out as to facilitate, with the aid of a stopwatch, the timing of behavior in units of five seconds We have thus a permanent record both of the precise series of responses made by each child throughout each experimental period and of the duration of each response or combination of responses, within a margin of five seconds In Figure 1 is reproduced the actual record of one experimental period. A detailed account of the method of record-taking will be reported in a separate paper A list of all the responses found to appear following the various stimuli presented during the course of the experiments is given in Table 1

Such a direct observational method, while it has obvious shortcomings as compared with instrumental recording of behavior, has great advantages, both in its greater flexibility and the wider range of responses for which records are obtainable Equally important is the fact of the relative simplicity and naturalness of the experimental situation, since the child is not circumscribed by and harnessed to a more or less elaborate apparatus of recording devices. It is more direct than the recording of responses through dictation to a stenographer, and permits the timing of responses, which the latter method does not. A given pattern of responses may take place and be recorded directly by the observer almost simultaneously with the behavior, and in a fraction of the time during which a description of these responses can be dictated During the verbal description of a given response, it is likely to have been already succeeded by other and different behavior Such lag is likely to be constant, and of variable duration, with the method of dictation. The dictation itself is, of course, likely to be a source of distraction to the subject.

[1]By "relevant" we mean, for instance, that when the child looked at the stimulus presented at the time or the experimenter, the fact of visual attention and its object were carefully recorded If, however, the child's visual attention was directed elsewhere during exposure of a given stimulus, that fact was recorded, but the object of attention not specified We did not take a record of whether the child looked at the ceiling, or the floor, or the walls, or the arms of the chair, or whatnot

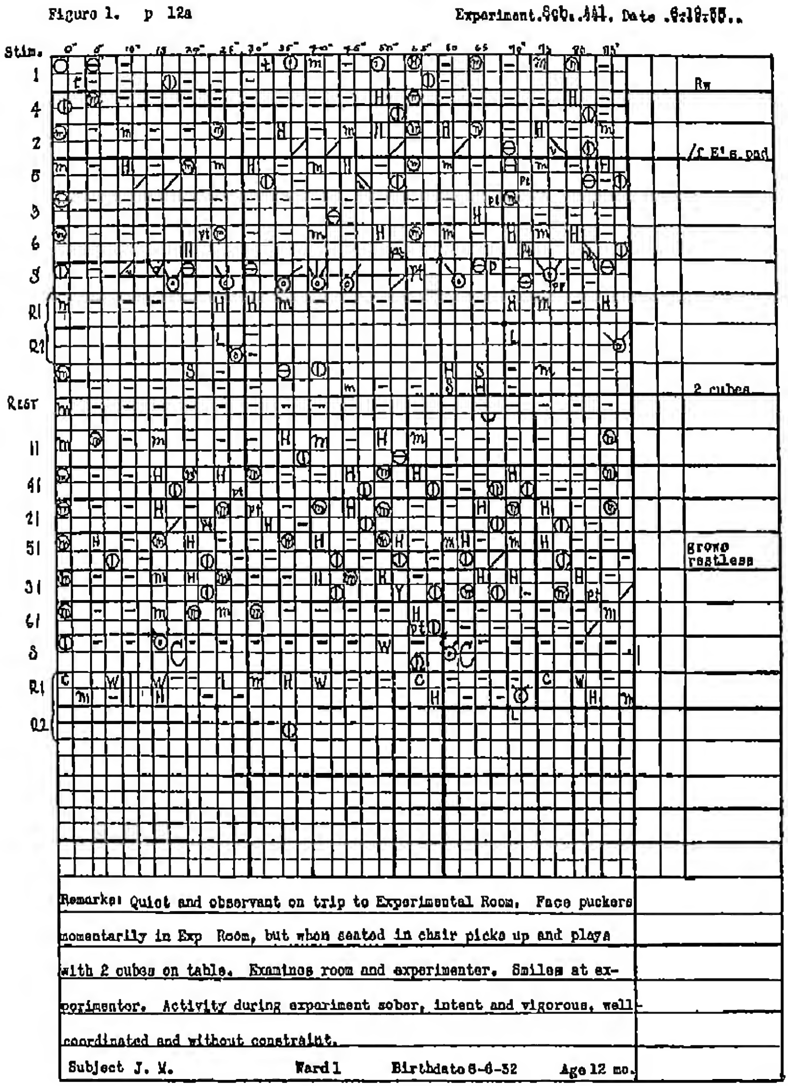
Figure 1. p 12a
Experiment
Date
Stim.
1
4
2
5
3
6
8
R1
R2
Rest
11
41
21
51
31
61
8
R1
R2
Rw
/£ E's pad
2 cubes
grows restless
Remarks: Quiet and observant on trip to Experimental Room. Face puckers momentarily in Exp Room, but when seated in chair picks up and plays with 2 cubes on table. Examines room and experimenter. Smiles at experimenter. Activity during experiment sober, intent and vigorous, well coordinated and without constraint.
Subject J. M.
Ward 1
Birthdate 6-6-32
Age 12 mo.

FIGURE 1

TABLE 1

LIST OF RESPONSES MADE BY ALL SUBJECTS DURING EXPERIMENTAL PERIODS

Manipulates stimulus presented
Touches lightly stimulus presented
Flips or fingers stimulus presented
Pats stimulus presented
Grasps stimulus presented
Holds stimulus presented and does something else, visual attention elsewhere
Drops stimulus presented
Reaches for stimulus presented
Sucks or mouths stimulus presented
Pushes stimulus presented
Pushes stimulus presented off table, or throws
Turns away from stimulus presented, tries to get away from
Resists withdrawal of stimulus presented
Visual attention to stimulus presented, no contact, unless otherwise indicated*
Contact with stimulus presented, no visual attention
Visual attention to experimenter
Visual attention elsewhere than to experimenter or stimulus presented
Eyes search or turn in given directions
Head and eyes turn in given directions
General visual exploration
Looks up or straight ahead
Blinks
Listens
Vocalizes
Scolds
Whimpers
Cries vigorously—moderately—gently
Face puckers, or frowns
Face puckers and skin flushes, as if preparatory to crying
Respiration altered—breathes faster, deeper, irregularly
Sighs
Coughs
Sneezes
Yawns
Rubs eyes, nose or face (Responses generally noted to follow or substitute for crying or other negative responses)
Rests head on arms on table
Arms jerk
Legs jerk
Head and arms jerk or head, arms and legs jerk
Sucks thumb
Sucks fingers
Sucks or licks hand
Sucks dress
Pats table
Fingers table

*Unless otherwise indicated, all other responses to visual stimuli imply visual attention

TABLE 1 (*continued*)

Scratches table
Manipulates or fingers brass uprights
Activity other than with stimulus presented or attention to experimenter
Changed activity but still other than with stimulus presented
Smiles
Laughs
Kicks legs playfully
Kicks legs and waves arms playfully
Claps hands
Rocks self in chair
Beats time to music with stimulus presented
Maintains antecedent activity
Arrest of antecedent activity
Both hands engaged in an indicated activity
Hands alternate in an indicated activity

The Interpretation and Evaluation of Responses

The responses were classified into three categories, Negative, Positive and Indifferent, and were called N, P, and I, respectively Responses in any way indicative of distress or displeasure, crying, whimpering, scolding, puckering of the features, were called negative responses; responses indicating pleasure, smiling, laughing, etc. were called positive Any kind of play or other evidence of attraction toward a stimulus was also called a positive response: manipulation, grasping, fingering, etc. *The N and P responses were in addition* given numerical adscripts on a rough scale of 10, according to the nature, intensity, and duration of the response. Responses indicative of indifference to a given stimulus were unscaled, simply called I. The scheme used thus to classify the responses is given in Table 2

By this scheme each response which followed any stimulus was given a score P, N, or I The total series of responses during a single period of exposure to a stimulus were given a single score, equal to *the maximum N or P score during that period* In the cases of the stimuli St1 to St6 and R1, there would be such a score for each stimulus for each period of 90 seconds during which it was before the child In the cases of S and R2 there would be such a score for the responses following each S and each R2 for the interval until the next S or R2 in a given 90-second period The score for the last S or R2 in a 90-second period would represent the re-

TABLE 2

Scheme for Scoring Behavior Following Presentation of S, R1, R2, or Any St

	Responses	Score
Negative	Cries—continuously for 90″ or prolonged into time of presentation of a new stimulus	N10
	—continuously, from first S to second S—20″	N 9
	continuously, less than 20″	N 8
	—*intermittently*	N 7
	Whimpers, or cries 5″ or less	N 6
	Face puckers—skin flushes—frowns	N 6
	Scolds	N 5
	Jerks arms, legs, head	N 5
	Rubs eyes, nose or face — Following a preceding negative response, or if previously observed to have been a substitute for or complement to negative response	N 5
	Hides or rests heads on arms — Following a preceding negative response, or if previously observed to have been a substitute for or complement to negative response	N 5
	Sucks finger — Following a preceding negative response, or if previously observed to have been a substitute for or complement to negative response	N 5
	Respiration altered	N 3
	Rejects—pushes away, if unaccompanied by other affective response	N 5
	—if accompanied by crying or other signs of dislike give score of affective response	
	Attempts to get away from	N10
Positive	Manipulates stimulus presented—continuously during exposure time (90″)	P10
	—for one-half or more of 90″ period	P 9
	—for less than one-half of 90″ period	P 8
	—momentarily only—5″	P 7
	Carries stimulus to mouth	P 8
	Grasps stimulus, *pushes* or pats, fingers or touches continuously	P 7
	one-half or more of 90″ period	P 6
	less than one-half of 90″ period	P 5
	momentarily only—5″	P 4
	Holds but engages in other activity	P 4
	Reaches for momentarily	P 3
	Reaches for 10″, or more than once	P 4
	Reaches for persistently	P 5
	Looks at attentively, continuously or intermittently for total of more than 30″	P 3
	Looks at for less than 30″ either continuously or intermittently	P 2
	Looks at intermittently and fleetingly only, after initial observation	P 1

TABLE 2 (*continued*)

	Responses	Score
	Stops crying and smiles or otherwise gives signs of pleasure	P10
	Stops active manipulation and smiles or gives signs of pleasure	P 9
	Shows signs of pleasure, vocalizes, etc but continues to manipulate	P 8
	Stops manipulation to listen	P 7
	Listens to	P 5
	Listens to, beats time with toy	P 6
	Stops crying permanently	P 9
	Stops crying temporarily	P 8
	Stops crying momentarily	P 7
	Rocks self, or self and toy in time to music	P 9
	Laughs	P 8
	Smiles	P 5
	Vocalizes	P 8
	If accompanied by manipulative responses, increase score of each response by 2—Laugh; 1—Vocal; 1—Smile; 1—Kicks, etc	
	Waves arms and kicks legs in apparent euphoria	P 4
	Resists or cries when stim is taken away—Increase score of antecedent response by 1	
Indifferent		
	Apparent disregard—no overt response beyond first glance at	I
	—antecedent activity uninterrupted	I
	Looks at only momentarily—does not reach for	I
	Looks at experimenter or anywhere else	I
	Engages in any activity other than with stimulus presented	I
	Head or eyes turn to or seem to reach for source of sound	I
	Antecedent activity arrested (following S)	I
	Eyes blink	I

sponses subsequent to the presentation of that stimulus until the termination of that period If both positive and negative reactions were present during a single period, the score for the stimulus presented

in that period was PN, each letter followed by the appropriate numerical adscript. Negative responses present during exposure of a given St were credited to the stimulus equally whether the negative behavior had persisted from an earlier situation or appeared to be specifically aroused by the stimulus itself

Before proceeding to analysis of the records and study of the changes in behavior with respect to the St series of stimuli, it will be well to present evidence for S as an adequate startle or disagreeable stimulus and for R1 and R2 as agreeable stimuli

The Evidence for S as a Startle Stimulus

It has already been noted that only subjects who responded negatively to S were retained for the experimental training Of the 15 children who comprised the experimental group all gave negative responses to at least 6 of the 8 S stimulations given during Schedules A-A1 and B-B1, the two preliminary test periods Of the total of 120 S stimulations given to all 15 children during these two sessions, 105 or 87½% were responded to by crying. In only 4 instances, 3 1/3%, was the response that of indifference The balance were negative responses not so intense as to produce weeping

The responses which followed upon S during the training periods when it was presented jointly with St1, St2, or St3 are summarized in Table 3. S was rung four times during the presentation each of St1, 2 and 3 in Schedule C, and four times again during one presentation each of the same St in Schedules D1D2. There are thus, for fifteen subjects, a total of 180 S stimulations during C and a like number during D1D2 in the first cycle of training For the 13 subjects who were carried through a second cycle of training, there are 156 additional S during Schedules C and D1D2 each Table 3 gives the total—in number and per cent—of each type of response to S during these Schedules, for each cycle of training. The responses of the two subjects who were carried through four and three cycles of training, respectively, are not given. The responses are consistent with those shown here. Both subjects continued to cry whenever S was sounded to the very end of the training

Table 3 shows clearly that the characteristic and predominating response to S throughout the training periods was that of emotional distress. The proportion of responses indicating indifference to the stimulus are practically negligible, except in the first session of the

TABLE 3

THE RESPONSES TO S DURING TRAINING

Responses	First cycle—15 subjects 360 S						Second cycle—13 subjects 312 S					
	Sch C		Sch D1D2		Total		Sch 2C		Sch 2D1D2		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Indifference	5	3	10	6	15	4	27	17	5	3	32	10
N5—Jerks arms, legs, etc	2	1	9	5	11	3	17	11	20	13	37	12
N6—Face puckers, whimpers	5	3	8	4	13	4	25	16	16	10	41	13
N7—10 Cries	168	93	153	85	321	89	87	56	115	74	202	65

second cycle of training, Schedule 2C During this period the negative responses were both less frequent and less intense than earlier. Adaptation to the stimulus similar to but not so complete as that of Subject B.M seemed to have set in during this period with some children, although the cumulative effect of S, a fact which had been noted during the course of the preliminary periods, may be observed in the restoration of many N responses during Schedules 2D1D2 Throughout the whole second cycle of training, however, the negative responses, even though they comprised 90% of the total, were less intense than those first made to the stimulus Even when the reaction was that of crying, the cry itself was observed in many cases to be of a different character than formerly, less startled and fearful and much more in the nature of an habitual complaint.[6]

The Evidence for R1 as an Agreeable or Pleasure-Giving Stimulus

R1 was the double red rattle. During the preliminary periods —Schedules AA1 and BB1—it was presented a total of 60 times, four times to each subject, having been directly preceded each time by 2 successive S stimulations In 55 of these 60 instances the subjects were crying, following the antecedent S stimulus In 43 of these instances, 78%, the crying was interrupted by the appear-

[6]It may need comment that a startle response to the ringing of a bell was so general a reaction The ringing of ordinary electric bells, telephone bells, and house bells are no new experience to babies brought up in either their own homes or in institutions If negative reactions originally occur to these, adaptation sets in early so that startle responses, except when occasionally a child may be wakened from sleep, are rare The babies in this institution, as children commonly are in city hospitals and other city institutions, are also subjected to the sound of an electric signal gong within the building, the clang of trolley car bells and the clamor of motor horns without These sounds are not commonly disturbing The sources of such sounds, however, are always remote from the child, even though the sounds themselves are often penetrating and intense

The stimulus S, on the contrary, originated from the child's immediate neighborhood. Although distinctly unmusical, and irritating to adults who heard it, S was not an especially loud sound, since it was desirable to avoid annoyance to individuals outside of the experimental room The frequency of startle responses obtained to it seemed to be due as much to the unwonted closeness of the sound, as to the harsh and grating character of the stimulus itself and the abruptness of its appearance The fact that *relatively few startle reactions* were obtained from a small group of infants in another institution, S having been hung at some distance from the subjects, seems also to confirm this

ance of R1; in 26 instances it was terminated thereby The rattle was picked up and played with in 65% of the presentations Manipulation lasted for ten seconds or more in 54% of the presentations.

When the responses to R1 during Schedules AA1 and BB1 were compared with the responses to each of the St shown earlier in the same period (i e, the responses to R1 in Schedule A compared with the responses to each of St1 to St6 shown earlier in that schedule, the responses to R1 in schedule A1 compared with the responses to each of St11 to 61, etc) with respect to degree of interest as evidenced by the P scores, it was found that the responses to R1 indicated greater interest in it than in any of the St 52% of the time Interest in R1 was equal to interest in the several St in 22% of the comparisons so made and less in 26% There were a total of 330 such comparisons

During the training periods R1 was always presented together with St4, 5, or 6 Both objects were placed on the table before the child simultaneously, R1—in random order—to the right, left, in back, in front, or on top of, the St it accompanied. We may, perhaps, best judge of the attractiveness of R1 by comparing the responses to it with the responses to the St when both an St and R1 were presented at the same time

There were a total of 189 such joint presentations, 63 for each St In 71% the responses to R1, as shown by the P scores, gave clear evidence of its greater attractiveness to the subjects; in only 6% of the situations was an St preferred. In 23% the responses to R1 and St were similar. The median response to R1 for the 189 situations was found to be P9—active manipulation for more than half of the exposure time of 90 seconds, to the St during these periods it was P4, momentary touching or grasping or holding while engaged in activity with another stimulus. In somewhat over one-third of the situations—36% exactly—the subjects were completely indifferent to the St when R1 was present. They were indifferent to R1 in only 13 instances, 7%, under the same circumstances

The Evidence for R2 as an Agreeable or Pleasure Giving Stimulus

The melody, R2, was played a total of 99 times during the preliminary periods—Schedules AA1 and BB1—twice each time

the rattle R1 was presented. It was played a total of 360 times during the training periods, twice during each joint presentation of R1 with an St[6] In 27% of the preliminary trials, in 33% of the presentations during training, its power to please or soothe the subjects was unmistakable, as evidenced by responses such as smiling, vocalizing, beating time to, ceasing from fretting, interrupting play with the rattle to listen to. In 28% of the trials before training, in 14% during training the children appeared simply to listen to the stimulus, but gave no special indications of pleasure in it. In very nearly half of the presentations of R2, the subjects were *apparently completely indifferent* to the stimulus No overt responses to R2 could be observed in 45% of the preliminary trials, in 52% of the presentations during training

Thus the case for R2 as a pleasure-giving stimulus is not as strong as might be desired It should be remembered, however, that the subjects were for the most part engaged in active and vigorous play with R1 whenever R2 was played Overt responses indicating the agreeableness of an auditory stimulus under such circumstances would be difficult to elicit In any case, such responses are subtle, less easily aroused and interpreted than emotional distress in infancy Whether or not the pleasure produced by R1 and R2 was equal to, or as acute, or pervasive, as the distress occasioned by S, there can be little question that R1 and R2 in combination *provided for St4, 5, and 6 a setting in distinct contrast with that* produced by S for St1, 2, and 3

The Results

Taking into consideration the character of the initial response to any St, the changes in behavior which might occur with respect to that St may be grouped as follows.

I Change to negative or intensification of negative	Any final response scored N or PN which originally was P or I
	Any final response scored N which originally was PN
	Any final response scored PN which originally was N, or PN, in which final N is greater than original N.

[6] According to the experimental schedules, a total of 120 presentations of R2 before training and of 372 during training are to be expected The first three subjects, however, were, to begin with, given sugar in various forms, lump, pellet, syrup, as R2 The music box was substituted and used throughout with all other subjects, when the sugar proved to be not readily acceptable by the first three babies

II	Change to indifference	Any final response scored I or P1, P2, or P3 which originally was P4 or more or N or PN
III	Waning interest	Any final response scored P4 or more which was originally scored a greater P Any final response scored PN which was originally PN and in which final P is less than original score, and N is equal to or less than original score
IV	Unchanged	Any final response the score for which was identical with score for original response or which if originally I, P3, P2, or P1 became any one of these
V	Increased interest	Any final response scored P which was originally I Any final response scored PN which was originally PN if final P is greater than original P and final N equal to original score.
VI	Loss of negative or diminution in negative	Any final response scored P which was originally N or PN Any final response scored PN which was originally PN and in which P is equal to or greater than original score and N is less than the original score. Any final response scored PN which was originally N if N is less than the original score Any final response scored N which was originally N in which N is less than original response

In Table 4 are presented the results of grouping, according to this plan, the changes in the responses of all subjects to the St, following each cycle of training The table gives the totals for St1, 2, and 3 and for St4, 5, and 6 in each classification If the repeated S and R1R2 were potent to modify the behavior toward the St with which they were respectively associated in accordance with the characteristic reactions which they aroused, we should expect the changes in behavior to the two groups of St to tend in opposite directions Most of the change to St1-2-3 should be found in Group I "Change to Negative," while at the same time the behavior toward St4-5-6 should show increased interest or attraction toward these St and the changes in behavior be found generally in Groups V and VI Negative changes with respect to St1-2-3 would be significant as to the effect of S provided only

TABLE 4

CLASSIFICATION OF CHANGES FROM INITIAL RESPONSES TO St1-2-3 AND St4-5-6 AFTER EACH CYCLE OF ASSOCIATION WITH S AND R1R2, RESPECTIVELY (Totals for St1, 2, and 3 and for St4, 5, and 6)

		Cycle 1 15 subjects		Cycle 2 13 subjects		Cycle 3 2 subjects		Cycle 4 1 subject	
		St 1-2-3	St 4-5-6	St 1-2-3	St 4-5-6	St 1-2-3	St 4-5-6	St 1-2-3	St 4-5-6
I	Change to negative	12	13	6	5	2	2	1	0
II	Change to indifference	4	1	2	0				
III.	Change to waning int	3	6	7	7	1	0	0	1
IV	No change	5	8	4	4	2	2	0	1
V.	Change to increased int.	15	9	16	18	1	1	1	0
VI	Change to increased int with loss or dim of original response*	6	8	4	5	0	1	1	1

*Group VI is so called since only one change in this group was not accompanied by an increase in interest. All but one of the final responses also showed complete elimination of the original negative responses.

that similar changes had not taken place with respect to St4-5-6; and conversely, positive changes in attitude to St4-5-6 would be significant as to the effect of R1R2 provided only that St1-2-3 had not also grown in interest. With increased training, we should expect such differences in behavior to grow more marked

Such is not the case At the end of the first cycle of experiments negative changes for St1-2-3 do not appear more frequently than they do for St4-5-6, nor have St4-5-6 grown more attractive to the subjects than have St1-2-3. To both sets of stimuli the most frequent change was that of increase in interest This tendency persisted after the additional training of the second cycle, whereas the changes to negative for St1-2-3 as well as for St4-5-6 grew less frequent as the experiment was prolonged Systematic changes in behavior to either series of St corresponding to the effect of either S or R1R2 on the subjects, and which might be specifically attributed to them do not appear

This is even clearer if we follow through the individual records of change These are given in Tables 5 and 5A The records of the subjects who at any time showed negative change to St1-2-3

TABLE 5

CHANGES FROM INITIAL RESPONSE TO EACH ST AFTER EACH CYCLE OF TRAINING IN SEVEN SUBJECTS WHO SHOWED NEGATIVE CHANGE TO ST 1-2 OR 3 AT SOME TEST PERIOD

Subject	St 1	2	3	4	5	6	1	2	3	4	5	6
			Cycle 1						Cycle 2			
JG	+	+	++	+	0	++	Wa	+	++	+	Wa	++
CG	—	—	+	—	Wa	+	In	Wa	Wa	Wa	Wa	+
HB	—	—	—	—	—	—	In	—	Wa	+	—	—
RW	—	—	0	—	—	—	—	Wa	—	Wa	Wa	0
JM	—	—	+	—	Wa	+	Wa	Wa	0	Wa	Wa	+
SS	—	—	—	—	—	—	—	—	+	—	—	+
DL	++	++	+	++	++	+	+	+	—	+	+	—
			Cycle 3						Cycle 4			
JG	—	—	0	—	—	++	—	+	++	Wa	0	++
CG	Wa	0	+	0	0	+						

TABLE 5A

CHANGES FROM INITIAL RESPONSE TO EACH ST AFTER EACH CYCLE OF TRAINING—8 SUBJECTS WHO SHOWED NO NEGATIVE CHANGE TO ST 1-2-3

Subject	1	2	3	4	5	6	1	2	3	4	5	6
JW	+	+	+	Wa	Wa	0	+	+	0	+	+	+
DN	In	Wa	I	In	Wa	0						
BM	+	0	Wa	Wa	0	+						
SK	0	+	++	+	+	++	+	+	++	+	+	++
PH	+	+	+	+	0	+	+	+	+	+	0	+
AG	++	++	++	++	++	++	++	++	++	++	++	++
SC	+	Wa	0	—	—	+	+	+	0	+	+	+
FL	In	0	0	0	0	0	+	+	0	0	0	+

Legend
— Represents change to Negative
In Represents change to Indifference
Wa Represents change to Waning Interest
\+ Represents change to Increased Interest
++ Represents change to Increased Interest with loss of negative, etc.
0 Represents no change

following training appear in table 5, the records of the others in Table 5A Five children, CG, HB, RW, JM, and SS show negative change at the end of Cycle 1, to one or more objects in the St1-2-3 series, but the same five show the same change at this time to St4, and three of the five to St5 and St6. At the end of the second cycle the responses of these five subjects show fewer negative changes and these appear indiscriminately in both series of St Study of the records of the remaining subjects will reveal no change which can reasonably be attributed to the effect of S and R1R2.

All the babies exhibited signs of uneasiness or wariness when they were first carried through the corridors of the building to the room in which the experiments were carried out. To these children such a journey was unprecedented Unless a child had been ill and in the hospital or infirmary, it was rarely, if ever, taken outside of its own ward or the porch which adjoined it. None of the subjects gave marked expressions of disquiet, however, during the trip, which was never more than down one flight of stairs and along about 100 feet of corridor These were held in check by the children until the S, during the first period, in a sense, confirmed the latent alarm Thereafter the negative reaction which followed S in the first period tended to persist as a generalized response throughout the balance of this period and to appear again in subsequent experimental periods The generalized alarm, however, grew gradually less and in all except Subjects HB, RW, and SS had practically disappeared by Schedule E. By 2C it was well dissipated in all children The first cycle of training was therefore largely a period of adjustment to the total situation. Once this had taken place the responses became specific and appropriate to the stimuli presented and tended to remain so.

The Effect of S after Three Minutes

Tables 4, 5, and 5A show the effect of S on St1-2-3 twenty-four hours after the simultaneous presentation of S with St Our data enable us to study also the more immediate effect of S It will be recalled that in Schedules D1 and D2, St1-2-3 each were presented twice alone, just before and after S was combined with each The child was given an St for 180 seconds During the first 90 seconds of the period S was not sounded; during the second 90 seconds S was rung four times The St was then removed for

180 seconds. At the end of this time, the St was again presented and left with the child for 90 seconds. Table 6 shows how the responses to each St after S differed from those which preceded it The effect of S after 3 minutes seems no greater than its effect after 24 hours The responses showing increase of interest are just about as frequent as those showing negative change or no change at all

TABLE 6

CHANGES IN RESPONSE TO St1-2-3 IMMEDIATELY FOLLOWING ASSOCIATION WITH S SCHEDULES D1D2 CYCLES 1+2

		D1D2 Cycle 1—15 subjects				2D1D2 Cycle 2—13 subjects			
	Change to	St 1	2	3	Total	St 1	2	3	Total
I.	Negative	4	2	6	12	4	4	2	10
II	Indifference					1	1		2
III.	Waning interest	2	4		6		2	4	6
IV.	No change	5	6	5	16	4	2	4	10
V.	Increased int	1	1	4	6	4	3	2	9
VI	Increased interest, Elim or dim of orig neg	3	2		5		1	1	2
Total					45				39

THE RESPONSES AFTER TRAINING TO THE DERIVATIVE STIMULI

It was our plan, if we had been able to bring about modifications in behavior to St1-2-3 and to St4-5-6, the major series of stimuli, which could be attributed to S and R1R2, to test how general such modification might be, by presenting to the subjects both before and after training a series of derivative stimuli resembling but not identical with the major series, and observing the extent of transfer The derivative St were presented to the subjects before and at the conclusion of training, in accordance with the original plan, although S and R1R2 were observed as the experiment progressed to be without effect on the behavior toward the major St.

There were ten such derivative stimuli for the St1-2-3 series, and six in the St4-5-6 series. Eleven of the thirteen children were tested with the derivatives at the conclusion of the second cycle of training, one child at the conclusion of the third cycle, one at the conclusion of the fourth cycle. (One subject missed the final trial

with the derivative series, owing to illness; for the same reason another child could be given only part of the series. Subject B.M., who ceased to show startle to S was also not tested with the derivatives.) Of a total of 123 final responses to the St1-2-3 derivative series, 79% showed increase of interest over the initial responses to the same stimuli. Of a total of 75 final responses to St4-5-6 derivatives, 77% showed increase of interest over the initial responses. *The frequencies of the other changes are negligible in comparison.* Waning interest was exhibited in 8% of the final presentations of the St1-2-3 derivatives, in 13% of the St4-5-6 derivatives. No changes appeared in 6.5% and 7% of the final responses to the members of two series, respectively. The incidence of negative change to the St1-2-3 derivatives was 6.5%, slightly greater than the negative change to the St4-5-6 derivatives, which was 3%. But the difference, 3.5%, is not at all reliable. It is only 1¾ times its probable error, 2%.

Summary and Conclusions

We have attempted to modify, by the method of conditioning, the original overt behavior of fifteen infants to a series of stimuli, St1 to St6, which in themselves were without intrinsic biological interest or significance, wooden objects of various geometrical shapes, colors, and patterns, cloth curtains also varied as to color and pattern. With half of these, St1, St2, and St3, were regularly associated a disagreeable conditioning stimulus, with the other half, St4, St5, and St6, were associated agreeable stimuli, under circumstances which otherwise were identical. The experiment thus provided a means whereby changes seemingly consequent upon one kind of joint stimulation could be checked by comparison with the changes following upon the contrasted, associated emotional situation. The disagreeable stimulus, S, was the startling ring of an electric bell; a toy and a little music box tune constituted the agreeable stimuli, R1R2.

The initial cycle of test-training-test series for a given child covered six experimental days. Additional cycles of training added four or five experimental days each. A single cycle provided 24 S stimulations of one second duration each, jointly with the appropriate St, six presentations of R1 for 90″ each, 12 presentations of R2 for 10″ each. Eleven babies were carried through two cycles

of training, two through one cycle, one child through three cycles, and one through four

A careful record was made during the experiment of all the responses to each of the stimuli, before and after training, and when presented jointly. Subsequently, the responses were classified as negative, positive, and indifferent, with respect to each stimulus, and scaled in accordance with their duration and intensity Negative reactions were those indicative of startle, fear, or distress; positive, those indicative of interest, pleasure, relief or contentment.

Study of the responses to S and to R1R2 show them to be adequate startle and pleasure-giving stimuli, respectively Comparison of the responses to St1 to St6 before and after training, fails to provide any evidence of the effect of joint stimulation Negative changes in behavior, after training, appeared as frequently toward St4-5-6, which were associated only with R1R2, as toward St1-2-3 with which S was associated; and *vice versa,* positive changes in behavior appeared as frequently toward St1-2-3 as toward St4-5-6 Difference in modification of response to the two sets of St are slight and without statistical significance.

We are therefore led to conclude that changes in emotional behavior, in attitude and interest, are not as a general rule, at least, readily brought about by joint stimulation in early life, and that conditioning *per se* cannot be accepted as the cover-all explanation of the emotional modifications which take place during that period

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UN ESSAI DE MODIFIER LES ATTITUDES ÉMOTIVES DES PETITS ENFANT AU MOYEN DE LA TECHNIQUE DE LA RÉPONSE CONDITIONNELLE

(Résumé)

On a fait l'essai de modifier, au moyen de la technique conditionnelle, les réponses émotives manifestes de quinze enfants, âgés de huit à seize mois, à une série de stimuli qui n'ont eu eux-mêmes aucune signifiance biologique intrinsèque ni intérêt—des objets de bois de diverses formes géométriques, *couleurs et dessins, et des rideaux de toile aussi de diverses* couleurs et dessins

À l'un groupe de ces objets on a associé le son d'un timbre électrique, qui a produit régulièrement des réactions de peur, de tressaillement et de détresse A un second groupe équivalent on a associé, dans des conditions autrement identiques, un jouet et une petite mélodie, des stimuli qui ont produit des réponses indiquant le plaisir, le contentment, et le soulagement Il a été possible ainsi de contrôler les changements de comportement conséquents, paraît-il, à l'association à l'un type de situation conditionnelle par la comparaison avec les changements qui ont suivi la situation émotive associée, contrastée

Une telle comparaison ne révèle aucuns changements de comportement qu'on peut attribuer raisonablement à l'effet spécifique des stimuli conditionnels Un changement negatif du comportement, c'est-à-dire, un changement vers la peur, le tressaillement ou la detresse, s'est montré aussi fréquemment après l'entraînement aux stimuli secondaires auxquels seulement les stimuli agréables ont été associés, que le changement vers les stimuli secondaires auxquels les stimuli désagréables ont éte associes, et vice versa, le changement positif, c'est-à-dire, le comportement montrant un intérêt et plaisir plus grands, s'est montré aussi fréquemment vers les stimuli associés au stimulus désagréable que vers ceux associés aux stimuli agréables Sur la base de ces résultats, on ne peut considérer le conditionnement comme l'explication générale des modifications émotives qui ont lieu dans l'enfance

BREGMAN

EIN VERSUCH, DIE GEFÜHLSATTITÜDEN KLEINER KINDER DURCH DIE BEDINGTE AKTIONSMETHODE ZU VERANDERN

(Referat)

Ein Versuchwurde gemacht, die offenbaren Gefuhlsaktionen funfzehn kleiner Kinder von acht bis sechszehn Monanten zu verandern durch die Methode des Bedingens zu einer Reihenfolge von Reizen, die an und fur sich ohne innere biologische Bedeutung oder inneres Interesse waren—holzerne Objekte verschiedener geometrischer Formen, Farben und Muster, Vorhange mit verschiedenen Farben und Mustern

Mit einer Gruppe von diesen Gegenstanden wurde der Laut einer elektrischen Glocke assoziiert, welche Reaktionen der Furcht, des Erschreckens und Schmerzes hervorbrachte Bei einer gleichartigen Gruppe Gegenstande wurden unter sonst denselben Umstanden ein Spielzeug und eine kleine

Melodie assoziiert, die Reaktionen der Lust, Zufriedenheit und Erleichterung erzeugten Dadurch war es moglich, die Veranderungen des Verhaltens festzustellen, die scheinbar auf die verglichene assoziierte Gefuhlssituation folgte

Solch ein Vergleich offenbart keine Veranderungen des Verhaltens, die der spezifischen Wirkung der bedingten Reize billig zugeschrieben werden konnen Negativ Veranderung des Verhaltens, d h Veranderung in der Richtung der Furcht, des Erschreckens oder Unbehagens, fand eben so haufig nach dem Bedingen zu den Nebenreizen, mit denen nur die angenehmen Reize assoziiert waren, statt, als zu den Nebenreizen, mit denen die unangenehmen Reize assozirt waren, und umgekehrt, positiv Veranderung, d.h das Verhalten, welches mit einem vermehrten Interesse und Vergnugen verbunden war, erschien eben so haufig bei den Reizen, die mit dem unangenehmen Reiz assoziiert waren, als bei denen, die mit den angenehmen Reizen assoziiert waren Auf Grund dieser Befunde kann das Bedingen nicht als die allgemeine Erklarung fur die emotionelle Veranderung, die in der fruhen Kindheit vorkommt, angesehen werden

BREGMAN

AN ANALYTICAL STUDY OF CHILDREN'S SLEEP*

DORIS ERWIN

INTRODUCTION[1]

The child's mental growth, play activities, diet and health have received the attention of investigators for some time An equally important aspect of the child's development is that of his sleeping habits. However, the scientific study of sleep, as it is related to the needs of the child, has received considerably less attention

Authorities on the care of infants and children have stressed the importance of adequate sleep, but the many estimates as to how much sleep is necessary for optimum growth and development vary greatlv in the absence of actual records as to the amount of sleep which children really get. Consequently, the relation of such varying amounts of sleep as children actually get to health, growth, efficiency in school, and general personality development is very largely a matter of opinion.

This study was undertaken with the hope of making some contribution to these important considerations of sleep. Information has been sought to determine how much sleep children from two months to fourteen years of age were getting; how this was distributed during the twenty-four hours; and what factors might have an influence on the amount of sleep which children had The following questions are often raised, and, within the limits of this study, an answer was sought for each of them.

1. Do children actually have as much sleep as is advocated?
2. Are there any sex differences?
3. Do children sleep longer during one season than another?
4. Do children from various socio-economic levels show any consistent differences in the amount of sleep?
5. What influence do the immediate surroundings have on the length of sleep?

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[1]The writer wishes to express her appreciation to Dr T F Vance, Department of Psychology, and Department of Child Development, Iowa State College, under whose direction the problem was undertaken, and to Dr H V Gaskill, Department of Psychology, Iowa State College, for his help in the statistical aspects of the problem

6. Is there any correlation between sleep and intelligence, between sleep and school average, and between sleep and an introvert-extravert score?

Previous Studies

Much of the current literature on the experimental studies of sleep has been concerned with: (1) the deprivation of sleep over long and short periods of time, and (2) activities during sleep. Most of these studies have been concerned with adults.

Probably the most extensive investigation of the sleeping habits of young children is that of Foster, Goodenough and Anderson (9). Data regarding the amount of sleep of 1186 children from one month to seven years and eleven months of age were obtained by means of a return post card questionnaire sent to mothers in the state of Minnesota. Chant and Blatz (6) obtained information concerning the sleeping habits of children from one to eleven years of age from observation in the nursery school and from records kept by the mothers. The records of seventy-eight children attending the Merrill-Palmer school were analyzed by Flemming (8) in her study of the sleeping habits of preschool children. Sherman (17) investigated "some factors which influence the character and duration of the afternoon sleep of young children," while Osburn (13) investigated "the origin and evolution of sleep, with the subsequent development of sleep habits." The postures during sleep preferred by children in a nursery school were observed by Boynton and Goodenough (3). Staples (19) studied some of the factors influencing the afternoon sleep of young children, while White (23) was concerned with some factors affecting the night sleep of children. Shinn (18) compared the sleeping habits of two groups of preschool children, one in Hawaii and one on the mainland. The effect of daylight saving time upon the sleep of young children was investigated by Reese (15).

The most extensive study of the sleep of school children is that of Terman and Hocking (21) who obtained records for 2692 children six to twenty years of age who were living in the western part of the United States. These records were collected by the teachers in the schools.

At least three major investigations of the sleep of school children have been carried on abroad. Bernhard (1) obtained data from 6551 German children ranging in age from six to fourteen years. Ravenhill's (14) study included 6180 English children of corre-

sponding ages Hayashi (10) obtained sleep records for 5558 school children of six to twenty years of age from nine cities in different geographical areas of Japan.

Method

For studying the sleep of children, in any extended way, there seems to be no substitute for the systematic record on a carefully prepared form for a definite period of time For such a method to have high reliability careful attention should be given to the record form, the keeping of the record and the selection of the children.

The Record Form

Much thought was given to devising a record form which would include the information desired but which required a minimum amount of time and effort on the part of those keeping the records It was felt that the surroundings in the home as well as the health of the child would have an influence on the amount of sleep A preliminary form contained the same material as that of the final form but two sheets were needed for each day's record This form was later revised and condensed to two pages for the entire week in order that the keeping of the record would be facilitated for the mother

Keeping the Record

To insure the greatest reliability in a study of this kind the investigator herself or trained assistants should have gone into the homes of the children selected for this study to remain there until a complete record had been made for the stated period of observation Such a program while conducive to greater accuracy would, without the expenditure of much time and money, seriously restrict the number of cases.

The investigator has consequently depended upon the mother of the child or, in some instances, a mother substitute to keep the record.

It was felt that the records would be more accurate if the cooperation of the mothers was enlisted through a personal interview, explaining the purpose of the investigation and the method to be used in keeping the record The Department of Psychology at Iowa State College offered the services of its students in Child

Psychology for these interviews. For the most part each student visited three mothers. The investigator had similar interviews with the nursery school families and with eight other mothers.

At the time of the first visit, the cooperation of the mother was sought and the first page of the record, dealing with the health of the child and the physical conditions of the home, was filled out by the student. During this same visit the student was instructed to explain to the mother each step in the keeping of the record.

A week later the student again called at the home for the record. She was instructed to read the record before leaving to secure information concerning irregularities which might appear.

In so far as possible, the records were all taken during the same week and at intervals of approximately three months beginning July 14, November 2, February 1 and May 3. In the case of the children who had their naps at the nursery school, the record was kept by the teacher and was then transferred to the home record at the end of the week.

In addition to the data appearing on the records, the school average was secured from the office of the Superintendent of Schools and the intelligence quotient[2] from the files of the Department of Psychology for the children who were in school. The intelligence quotient and the introvert-extrovert score on the Marston Rating Scale (12) were secured from the nursery school files for the children who were in attendance at that place. Because it was not obtainable, this information had to be omitted for the children below five years of age who were not in nursery school.

Each record was reviewed carefully by the investigator to correct errors or discrepancies which might have been made in recording the total number of hours and minutes of sleep each day. At the same time, the hours and minutes were reduced to minutes, in order that the material might be treated statistically more readily. For convenience in punching the Hollerith cards the totals in each case were reduced to units of ten. For example, eleven hours and twenty-seven minutes were recorded as six hundred and eighty minutes rather than six hundred and eighty-seven minutes.

[2]Names of tests

Merrill-Palmer	Kuhlmann Anderson
Detroit Kindergarten	Stanford Binet

Selection of Children

The names, ages, and addresses of all children below fourteen years of age who were living in the fourth ward of Ames, Iowa, were secured from the school enumeration. This section of the city was chosen as it is the most accessible to the students who were cooperating in the collection of the data This list of names was further augmented by the nursery school roll at Iowa State College, together with the brothers and sisters of these children This rather extensive list formed a basis for the selection of the children

Even though no attempt was made to secure records from a selected group of children the fact must be borne in mind that the fourth ward of Ames is made up primarily of families who are connected with the college, so that the group was more or less selected.

In families of more than four children the mother was asked to keep only three records, as it was thought that inaccuracies would be more prevalent if a larger number were kept by one person

Obviously, the amount of detailed information which was given on each record was too large to make it possible for all points to be considered in this study Several of those which were of particular interest to the writers were decided upon as being the more usable at the present time However, a further study is planned to take into account those points which are of necessity omitted here

Approximately 1025 names were taken from the school enumeration and the nursery school roll A record was desired for each of these children, but in the interview with the mothers it was found that some of them would not be able to cooperate For this reason a fewer number of records than this were distributed. The sleep records for 681 children were returned, but of this number thirty-seven were not used because of apparent gross inaccuracies or stereotyped answers This left 644 records to be used in the study. The first group of records which was kept in the summer quarter was for the nursery school children The largest number of records was kept during the fall quarter, with each of the succeeding quarters showing a progressive decrease

It was desired to have records on the same child for each quarter However, in many cases this was impossible as illness in the home, absence from the city, or otherwise unforeseen situations arose which made it unwise to keep a record at the designated time. Moving

from the city, outside work of the mother, illness in the family, and a general lack of interest and unwillingness to cooperate account primarily for the absence of records in the remaining cases

Results

The distribution according to age, sex and quarter is given in Table 1 A class interval of six months is used for the ages through fifty-nine months; an interval of twelve months is used from sixty months to fourteen years. The population for the first year is less than that for other ages because of the fact that children of one year and less were not included in the school enumeration. The total number of records for each of the sexes is almost equal, there being a slightly greater number of records for girls

In Table 2 is a tabulation of the records for the mean total sleep according to age, sex, and quarter [3] This table includes the mean times for total sleep, together with the upper and lower limits for each sex and for the sexes combined. From this table, considering totals, it is apparent that the girls slept slightly longer than the boys. This is most apparent between the ages of 30 months and 120 months For example, from the 36-41-month age group for the fall quarter, the boys slept 12 hours 16 minutes and the girls slept 12 hours 59 minutes Again in the 42-47-month age level during the spring quarter the boys slept 12 hours 7 minutes while the girls slept 12 hours 45 minutes. These differences, though slight, show a trend toward longer sleep for the girls Foster, Goodenough and Anderson (9), Chant and Blatz (6), and Flemming (8) found only slight sex differences while Hayashi (10) reported that Japanese boys slept longer than girls [4]

Table 2 also shows seasonal differences in amounts of sleep. Up to sixty months the tendency is toward more sleep in the winter and spring quarters with the opposite tendency during the fall and summer, in which there are consistent decreases. For example, in the 30-35-month age group for the sexes combined the mean sleep for the winter quarter is 12 hours 49 minutes and for the spring quar-

[3]The nursery school at Iowa State College operates on the "quarter plan," coordinated with opening and closing dates for the college quarters

[4]No figures are given in the abstract of Hayashi's (10) paper, it is merely stated that "The average sleeping hours of girls under 15 years are shorter than those of boys by 20 minutes"

TABLE 1

DISTRIBUTION OF CASES ON BASIS OF AGE, SEX, AND QUARTER

Age in months	Boys Summer	Boys Fall	Boys Winter	Boys Spring	Boys Total	Girls Summer	Girls Fall	Girls Winter	Girls Spring	Girls Total	Total
0-5		1		1	2			1	1	2	4
6-11	2	5		1	8	1	3	2		6	14
12-17		6	2	2	10	3	5	4	1	13	23
18-23		8	3		11	1	9	4	2	16	27
24-29	3	8	9	4	24	1	8	6	4	19	43
30-35	6	7	4	4	21	5	6	5	2	18	39
36-41	1	10	8	5	24	3	10	6	5	24	48
42-47	4	7	1	4	16	3	8	6	3	20	36
48-53	2	9	5	3	19	2	7	10	7	26	45
54-59	4	9	7	4	24	3	8	5	3	19	43
60-71		12	8	4	24	2	11	7	5	25	49
72-83	1	12	11	6	30	2	8	9	2	21	51
84-95	2	13	3	1	19	4	12	3	1	20	39
96-107	3	9	9	2	23		8	9	3	20	43
108-119		10	3		13		12	7	3	22	35
120-131	2	7	5		14	1	9	9	7	26	40
132-143	1	7	2	1	11	1	11	5	1	18	29
144-155	1	8	7	1	17		6	3	1	10	27
156-168		4	1		5	1	2	1		4	9
Total	32	152	88	43	315	33	143	102	51	329	644

TABLE 2

Age in months	Sex	Summer Fr.	Summer Mean	Summer Upper limit	Summer Lower limit	Fall Fr	Fall Mean	Fall Upper limit	Fall Lower limit	Winter Fr.	Winter Mean	Winter Upper limit	Winter Lower limit	Spring Fr	Spring Mean	Spring Upper limit	Spring Lower limit
0-5	Boys	0								0				1	16 59	16 59	16 59
	Girls	0								1	18 36	18 36	18 36	1	17 19	17 19	17.19
	Both	0								1	18·36	18 36	18 36	2	17 09	17.19	16 59
6-11	Boys	2	14 46	14 53	14·40	5	14 16	15 18	13 00	0				1	13.24	13:24	13:24
	Girls	1	14 04	14 04	14 04	3	13 13	13 55	11 46	2	14 47	14 47	14 47	0			
	Both	3	14 32	14 53	14.28	8	13 52	15 18	11 46	2	14 47	14 47	14 47	1	13.24	13 24	13.24
12-17	Boys	0				6	13 11	13 48	12 18	2	12 49	13 05	12 31	2	15.21	15 41	15 01
	Girls	3	12 49	13 04	12 41	5	13 58	14 43	12 38	4	13 17	13 54	12 00	1	14.25	14:25	14.25
	Both	3	12 49	13 04	12 41	11	13 32	14 43	12 18	6	13 08	13 54	12 00	3	15 03	15 41	14.25
18-23	Boys	0				8	13·12	13 55	12 30	3	13 47	14 41	13 14	0			
	Girls	1	13 00	13 00	13 00	9	13.11	13.21	12 40	4	13 31	14 00	13 08	2	12 32	12.38	12·27
	Both	1	13 00	13 00	13 00	17	13 11	13 55	12.30	7	13 39	14 41	13 08	2	12 32	12.38	12.27
24-29	Boys	3	12 46	12·53	12 42	8	12:13	13 10	10 49	9	12.30	13 16	11 39	4	13.23	14.25	13 03
	Girls	1	12 25	12 25	12.25	8	12 44	13 34	12 16	6	12 33	13 01	11 40	4	12 16	12 38	11 52
	Both	4	12 41	12 53	12.25	16	12 28	13 34	10 49	15	12 31	13 16	11 39	8	12 49	14 25	11 52
30-35	Boys	6	12.25	13 59	11 04	7	12 04	12·46	11 34	4	12 47	13.20	12 14	4	12 10	12.27	11 54
	Girls	5	11 55	12 17	11 14	6	11 56	12.35	11·38	5	12 50	13 31	12 14	2	13 02	13 04	13 01
	Both	11	12 11	13 59	11 04	13	12 00	12 46	11 34	9	12 49	13 31	12 14	6	12·28	13 04	11 54
36-41	Boys	1	12.21	12.21	12 21	10	12 16	13 20	11 35	8	11 58	12 49	11.35	5	12.42	13.54	11 04
	Girls	3	12 55	13 19	12 07	10	12 59	14 50	12 58	6	12 26	12 47	12 15	5	11 58	13 54	11 47
	Both	4	12 47	13 19	12 07	20	12 42	14 50	11 35	14	12 11	12 49	11 35	10	12.20	13 54	11 04
42-47	Boys	4	11 08	11 46	10 51	7	11·51	12 50	10 31	1	11·53	11 53	11 53	4	12 07	12 16	11 40
	Girls	3	11 39	11 49	11 21	8	11 31	12.21	10 17	6	12 01	13 38	12 04	3	12 45	14 11	11 32
	Both	7	11.22	11 49	10 51	15	11 40	12 50	10 17	7	12 00	13 38	11 53	7	12.23	14 11	11 32
48-53	Boys	2	11 32	12 00	11 05	9	11 29	11 51	9 40	5	11 42	12 05	10 44	3	11 56	12 38	11 34
	Girls	2	11 23	11 32	10 13	7	12 01	12 32	11 16	10	11 34	11 59	10 47	7	12 15	12 31	11·49
	Both	4	11 28	12 00	10 13	16	11 42	12 32	9 40	15	11 37	12.05	10 44	10	12 10	12 38	11 34

TABLE 2 (*continued*)

Age in months	Sex	Summer Fr	Summer Mean	Summer Upper limit	Summer Lower limit	Fall Fr.	Fall Mean	Fall Upper limit	Fall Lower limit	Winter Fr	Winter Mean	Winter Upper limit	Winter Lower limit	Spring Fr	Spring Mean	Spring Upper limit	Spring Lower limit
54-59	Boys	4	11 27	11 53	11 08	9	11.39	12 28	10.35	7	11 37	12 01	10 35	4	11 06	11 25	10 30
	Girls	3	11 27	11 28	10.25	8	11 40	12 19	10 50	5	12 05	12 53	11 47	3	11 58	13 36	11.11
	Both	7	11 27	11 53	10.25	17	11 39	12 28	10 33	12	11 49	12 53	10 35	7	11 32	13 36	10 30
60-71	Boys	0				12	11 25	11 39	10 54	8	11 20	12 05	10 53	4	11 14	12 17	10 06
	Girls	2	11 43	12.13	10 25	11	11.24	13 10	10 16	7	11 37	13 14	10 10	5	11 40	11 59	10 55
	Both	2	11 43	12.13	10 25	23	11.24	13 10	10 16	15	11 26	13 14	10 10	9	11.28	12 17	10 06
72-83	Boys	1	11 00	11 00	11 00	12	11 04	12 58	10 28	11	10 39	11 24	9 19	6	10 39	11 03	10.14
	Girls	2	10 59	10 59	10 59	8	10.50	11 35	10 17	9	11 04	11 24	10 34	2	11 05	11 31	10 38
	Both	3	10 59	11.00	10 59	20	10.59	12 58	10 17	20	10 54	11 24	9 19	8	10 46	11 31	10 14
84-95	Boys	2	10 51	11 10	10 32	13	10 49	11 17	10.23	3	10 53	11 05	10 47	1	10 11	10 11	10 11
	Girls	4	10 31	11 17	10 00	12	11 03	11 37	10 52	3	11.24	11.51	11 08	1	11 20	11 20	11 20
	Both	6	10.38	11 17	10 00	25	10 56	11 37	10 32	6	11 09	11 51	10 47	2	10 45	11 20	10 11
96-107	Boys	3	10.29	10 29	10 29	9	10 34	10 41	9 54	9	10.30	10 51	9 47	2	10 38	10 47	10 30
	Girls	0				8	10 43	11.21	10 23	9	11 17	15 34	9 42	3	10 22	10.41	9 53
	Both	3	10 29	10.29	10 29	17	10 38	11.21	9 54	18	10 54	15.34	9 42	5	10 29	10 47	9 53
108-119	Boys	0				10	10 37	11 38	10 32	3	10 29	10 46	10 00	0			
	Girls	0				12	10 37	11 01	10 12	7	10 50	11 08	10 30	3	10.26	10 30	10 20
	Both	0				22	10 37	11 38	10 12	10	10 44	11 08	10 00	3	10.26	10 30	10.20
120-131	Boys	2	10 02	10 02	10 02	7	10 13	10 40	10 00	5	10 55	11 31	10 47	0			
	Girls	1	10.27	10 27	10.27	9	10 10	10 40	9 38	9	10 51	10 50	10 01	7	10.22	10 49	10 04
	Both	3	10 10	10.27	10 02	16	10 11	10 40	9 38	14	10 40	11 51	10 01	7	10 22	10 49	10 04
132-143	Boys	1	9 56	9 56	9 56	7	10 11	10 34	9 49	2	9.58	10 19	9 38	1	9 44	9 44	9 44
	Girls	1	11 16	11 16	11 16	11	10 08	10 44	9 58	5	10.22	10 33	10.17	1	9 40	9 40	9 40
	Both	2	10.35	11 16	9 55	18	10 10	10 44	9 49	7	10 15	10 33	9 38	2	9.42	9 44	9 40
144-155	Boys	1	8 52	8 52	8 52	8	10 02	11 14	9 41	7	10 02	10 24	9 56	1	10 47	10 47	10 47
	Girls	0				6	10 02	10 42	9.26	3	10 06	10 38	9 47	1	10 31	10.31	10 31
	Both	1	8 52	8 52	8 52	14	10.02	10 14	9.26	10	10 03	10 38	9 47	2	10 39	10 47	10.31
156-168	Boys	0				4	9 10	9.38	9 02	1	9 27	9.27	9.27	0			
	Girls	1	9 04	9 04	9.04	2	9 26	9 43	9 10	1	9.20	9.20	9 20	0			
	Both	1	9 04	9 04	9 04	6	9 16	9 43	9 02	2	9.24	9.27	9.20	0			

ter is 12 hours 28 minutes, while the figures for the fall and summer quarters are 12 hours 0 minutes, and 12 hours 11 minutes respectively. From 60 months through the fourteenth year the fall and winter quarters show the greater amounts of sleep and the spring and summer quarters the lesser amounts.[5] This is true for each sex, as well as for the sexes combined. The figures for the age range for 84-95 months are 10 hours 56 minutes for the fall and 11 hours 9 minutes for the winter, and 10 hours 45 minutes for the spring and 10 hours 38 minutes for the summer. These figures are for the sexes combined. This is in accordance with Hayashi's findings.

Table 3 gives the mean day sleep according to age, sex, and quarter In examining the table for day sleep it is apparent that the distribution for the first 30 months is so scattered that it is difficult to draw definite conclusions. The boys have more day sleep than the girls from the 30-60 month. To illustrate, in the spring quarter for the 36-41-month age level the day sleep for boys is 1 hour 31 minutes as compared with 1 hour 27 minutes for the girls. Again in the fall quarter for the 48-53 month age level the figures for the boys are 1 hour 16 minutes while those for the girls are 46 minutes No definite trends appear in the age levels above 60 months as day sleep was not in the daily schedule in most instances by this time.

The figures for night sleep according to age, sex and quarter are given in Table 4 Here the figures for the girls are higher than those for the boys. For example in the fall quarter, in the 36-41-month age level the girls slept 11 hours 22 minutes and the boys 10 hours 48 minutes Again in the winter quarter, 24-29-month age level the figures for the girls are 11 hours 1 minute and for the boys 10 hours 57 minutes. This table also shows the superiority of the winter and fall quarters over the spring and summer quarters, as regards night sleep.

When the table for total sleep (Table 5) is referred to it is seen that the winter and fall quarters show the greater amounts of sleep. Hence it appears that night sleep is enough greater in these quarters to overcome the lesser amounts of day sleep and so to make the total day and night sleep for these quarters the larger.

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[5]Dr Samuel Renshaw, presenting a paper at the 1931 meeting of the American Psychological Association, reported that children of all ages sleep better in winter than in summer.

TABLE 3

MEAN DAY SLEEP

Sex	Summer Fr	Summer Mean	Fall Fr	Fall Mean	Winter Fr	Winter Mean	Spring Fr	Spring Mean
Boys	0		1	5 44	0		1	6 19
Girls	0		0		1	3 36	1	3 39
Both	0		1	5 44	1	3 36	2	4 58
Boys	2	2 21	5	2 31	0		1	3 08
Girls	1	3 51	3	2 04	2	2 33	0	
Both	3	2 51	8	2 21	2	2 33	1	3 08
Boys	0		6	1 50	2	1 46	2	2 47
Girls	3	1 38	5	2 30	4	2 03	1	2 51
Both	3	1 38	11	2 08	6	1 57	3	2 49
Boys	0		8	2,00	3	2 03	0	
Girls	1	1 57	9	2 11	4	1 50	2	2 04
Both	1	1 57	17	2 07	7	1 56	2	2 04
Boys	3	1 45	8	1 42	9	1 33	4	2 18
Girls	1	2 02	8	1 38	6	1 32	4	1 52
Both	4	1 50	16	1 40	15	1 32	8	2 05
Boys	6	1 40	7	1 19	4	1·58	4	1 29
Girls	5	1 36	6	0 59	5	1 39	2	2 01
Both	11	1 38	13	1 08	9	1,49	6	1 40
Boys	1	2 16	10	1 28	8	1 04	5	1 31
Girls	3	2 02	10	1 37	6	1 32	5	1 27
Both	4	2 06	20	1,32	14	1 17	10	1 29
Boys	4	0,58	7	1 19	1	1 09	4	1 46
Girls	3	1 30	8	0 49	6	0,55	3	1 50
Both	7	1 12	15	1·02	7	0 57	7	1 47
Boys	2	1 16	8	1 07	5	1 06	3	1 21
Girls	2	0,46	7	0·56	10	0 33	7	1,19
Both	4	1 01	15	1 02	15	0 44	10	1 20
Boys	4	1 10	5	1 09	6	1 19	4	1 01
Girls	3	1 02	7	0 19	5	0 40	3	1 01
Both	7	1 07	12	0 44	11	1 01	7	1 01
Boys	0		12	0 35	8	0 21	4	0 36
Girls	2	0 34	11	0 11	7	0 26	5	0 31
Both	2	0 34	23	0 24	15	0 22	9	0 33
Boys	0		12	0 09	0		6	0 16
Girls	0		8	0 03	0		0	
Both	0		20	0·06	0		6	0 16
Boys	0		0		3	0 04	0	
Girls	0		11	0 02	0		0	
Both	0		11	0 02	3	0 04	0	

TABLE 3 (*continued*)

Age in months	Sex	Summer Fr	Summer Mean	Fall Fr	Fall Mean	Winter Fr	Winter Mean	Spring Fr	Spring Mean
96-107	Boys	0		0		0		0	
	Girls	0		0		0		3	0 03
	Both	0		0		0		3	0 03
108-119	Boys	0		0		0		0	
	Girls	0		12	0 01	7	0 03	0	
	Both	0		12	0 01	7	0 03	0	
120-131	Boys	2	0 31	0		0		0	
	Girls	1	0.07	0		0		0	
	Both	3	0·23	0		0		0	
132-143	Boys	0		0		0		0	
	Girls	1	0 57	11	0 02	0		0	
	Both	1	0 57	11	0.02	0		0	
144-155	Boys	0		0		7	0 01	0	
	Girls	0		0		0		0	
	Both	0		0		7	0 01	0	
156-168	Boys	0		0		0		0	
	Girls	0		0		0		0	
	Both	0		0		0		0	

TABLE 4

MEAN NIGHT SLEEP

Age in months	Sex	Summer Fr	Summer Mean	Fall Fr	Fall Mean	Winter Fr	Winter Mean	Spring Fr	Spring Mean
0-5	Boys	0		1	12:16	0		1	11·03
	Girls	0		0		1	15·00	1	13 40
	Both	0		1	12 16	1	15 00	2	12 22
6-11	Boys	2	12.25	5	11·45	0		1	10·16
	Girls	1	10·13	3	11 09	2	12·14	0	
	Both	3	11·41	8	11 31	2	12 14	1	10 16
12-17	Boys	0		6	11 21	2	11 03	2	12 34
	Girls	3	11 11	5	11 28	4	11 16	1	11 34
	Both	3	11·11	11	11 26	6	11 11	3	12·14
18-23	Boys	0		8	11 12	3	11 44	0	
	Girls	1	11 03	9	11 00	4	11 41	2	10.28
	Both	1	11·03	17	11 06	7	11 43	2	10 28
24-29	Boys	3	11 01	8	10 31	9	10.57	4	11 05
	Girls	1	10 23	8	11 06	6	11.01	4	10.24
	Both	4	10.51	16	10 48	15	10 59	8	10 44

TABLE 4 (*continued*)

Age in months	Sex	Summer Fr	Summer Mean	Fall Fr	Fall Mean	Winter Fr	Winter Mean	Spring Fr	Spring Mean
	Boys	6	10 45	7	10 45	4	10 49	4	10 41
30-35	Girls	5	10 19	6	10 57	5	11·11	2	11 01
	Both	11	10.33	13	10 51	9	11 00	6	10 48
	Boys	1	10 05	10	10·48	8	10 54	5	11 11
36-41	Girls	3	10 52	10	11.22	6	10 54	5	10 31
	Both	4	10 41	20	11 05	14	10 54	10	10 51
	Boys	4	10 10	7	10 32	1	10 36	4	10 21
42-47	Girls	3	10 09	8	10 42	6	11 01	3	10 55
	Both	7	10 10	15	10 37	7	10 53	7	10 38
	Boys	2	10 16	9	10 30	5	10 37	3	10 34
48-53	Girls	2	10·37	7	11 05	10	11 01	7	10 56
	Both	4	10 27	16	10 45	15	10 53	10	10 50
	Boys	4	10 17	9	11 01	7	10 28	4	10 05
54-59	Girls	3	10 25	8	11 23	5	11 25	3	10 57
	Both	7	10 20	17	11 12	12	10 53	7	10 31
	Boys	0		12	10 50	8	11 02	4	10 38
60-71	Girls	2	11 09	11	11 13	7	11.11	5	11 09
	Both	2	11 09	23	11 02	15	11 06	9	10 53
	Boys	1	11 00	12	10 55	11	10 39	6	10 23
72-83	Girls	2	10 59	8	10 47	9	11 04	2	11 05
	Both	3	10 59	20	10 52	20	10 54	8	10 34
	Boys	2	10 51	13	10.49	3	10 49	1	10 11
84-95	Girls	4	10 31	12	11 01	3	11 24	1	11 20
	Both	6	10 38	25	10 55	6	11 06	2	10 45
	Boys	3	10 29	9	10 34	9	10 30	2	10 38
96-107	Girls	0		8	10·43	9	11 17	3	10 19
	Both	3	10 29	17	10 38	18	10 54	5	10 29
	Boys	0		10	10 37	3	10.29	0	
108-119	Girls	0		12	10 36	7	10 47	3	10 26
	Both	0		22	10·37	10	10 44	3	10.26
	Boys	2	9 31	7	10 13	5	10.55	0	
120-131	Girls	1	10 20	9	10 10	9	10 31	7	10 22
	Both	3	9 47	16	10 11	14	10 40	7	10 22
	Boys	1	9 56	7	10·11	2	9 58	1	9 44
132-143	Girls	1	10 19	11	10 06	5	10 22	1	9 40
	Both	2	10 05	18	10 10	7	10 15	2	9 42
	Boys	1	8 52	8	10 02	7	10 01	1	10·47
144-155	Girls	0		6	10 02	3	10 06	1	9 51
	Both	1	8 52	14	10 02	10	10 03	2	10 19
	Boys	0		4	9 10	1	9 27	0	
156-168	Girls	1	9 04	2	9 26	1	9 20	0	
	Both	1	9 04	6	9 16	2	9.24	0	

TABLE 5
MEAN TOTAL SLEEP

Age in months	Sex	Summer Fr	Summer Mean	Fall Fr	Fall Mean	Winter Fr	Winter Mean	Spring Fr.	Spring Mean
0-5	Boys	0		1	18 00	0		1	16·59
	Girls	0		0		1	18 36	1	17 19
	Both	0		1	18 00	1	18.36	2	17 09
6-11	Boys	2	14.46	5	14 16	0		1	13:24
	Girls	1	14.04	3	13 13	2	14 47	0	
	Both	3	14 32	8	13 52	2	14 47	1	13 24
12-17	Boys	0		6	13 11	2	12 49	2	15 21
	Girls	3	12 49	5	13·58	4	13 17	1	14 25
	Both	3	12 49	11	13 32	6	13 08	3	15 03
18-23	Boys	0		8	13 12	3	13 47	0	
	Girls	1	13 00	9	13 11	4	13 31	2	12 32
	Both	1	13 00	17	13 11	7	13 39	2	12 32
24-29	Boys	3	12 46	8	12·13	9	12 30	4	13·23
	Girls	1	12 25	8	12 44	6	12 33	4	12·16
	Both	4	12·41	16	12.28	15	12 31	8	12.49
30-35	Boys	6	12 25	7	12 04	4	12 47	4	12·10
	Girls	5	11.55	6	11 56	5	12·50	2	13 02
	Both	11	12 11	13	12 00	9	12 49	6	12 28
36-41	Boys	1	12 21	10	12 16	8	11·58	5	12 42
	Girls	3	12 55	10	12.59	6	12 26	5	11 58
	Both	4	12 47	20	12 38	14	12 11	10	12.20
42-47	Boys	4	11 08	7	11 51	1	11 53	4	12 07
	Girls	3	11 39	8	11 31	6	12 01	3	12 45
	Both	7	11 22	15	11 40	7	12 00	7	12 23
48-53	Boys	2	11·32	9	11 29	5	11·42	3	11.56
	Girls	2	11 23	7	12 01	10	11 34	7	12 15
	Both	4	11 28	16	11 42	15	11 37	10	12.10
54-59	Boys	4	11·27	9	11 39	7	11 37	4	11 06
	Girls	3	11·27	8	11 40	5	12 05	3	11 58
	Both	7	11 27	17	11 39	12	11 49	7	11 32
60-71	Boys	0		12	11 25	8	11 20	4	11 14
	Girls	2	11 43	11	11 24	7	11 37	5	11 40
	Both	2	11 43	23	11 24	15	11 26	9	11 28
72-83	Boys	1	11 00	12	11 04	11	10 39	6	10 39
	Girls	2	10 59	8	10 50	9	11 04	2	11 05
	Both	3	10·59	20	10 59	20	10·54	8	10 46
84-95	Boys	2	10 51	13	10 49	3	10 53	1	10 11
	Girls	4	10 31	12	11 03	3	11 24	1	11·20
	Both	6	10 38	25	10 56	6	11·09	2	10 45

TABLE 5 (*continued*)

Age in months	Sex	Summer Fr	Summer Mean	Fall Fr	Fall Mean	Winter Fr	Winter Mean	Spring Fr	Spring Mean
	Boys	3	10.29	9	10 34	9	10 30	2	10 38
96-107	Girls	0		8	10·43	9	11·17	3	10 22
	Both	3	10 29	17	10 38	18	10 54	5	10 29
	Boys	0		10	10 37	3	10 29	0	
108-119	Girls	0		12	10 37	7	10 50	3	10 26
	Both	0		22	10 37	10	10 44	3	10 26
	Boys	2	10 02	7	10 13	5	10 55	0	
120-131	Girls	1	10 27	9	10 10	9	10 31	7	10 22
	Both	3	10 10	16	10 11	14	10 40	7	10 22
	Boys	1	9 56	7	10 11	2	9 58	1	9 44
132-143	Girls	1	11 16	11	10 08	5	10 22	1	9 40
	Both	2	10 35	18	10 10	7	10 15	2	9 42
	Boys	1	8·52	8	10 02	7	10 02	1	10 47
144-155	Girls	0		6	10·02	3	10 06	1	10 31
	Both	1	8 52	14	10 02	10	10 03	2	10 39
	Boys	0		4	9 10	1	9 27	0	
156-168	Girls	1	9 04	2	9 26	1	9 20	0	
	Both	1	9 04	6	9 16	2	9 24	0	

Table 6 gives the argument in terms of age, and table entries are by socio-economic status of parents The occupational groups are an adaptation of the U S. Census report classification (20) The adaptation was necessary to prevent an undue proportion of cases from falling in one or two occupational groups.

Fifty-three per cent of the records fall in group 0 which is composed of fathers who were instructors in the college, members of the experiment station staff or working for degrees. The next group, comprising 6% of the total number of records included the children from the families of doctors, lawyers, ministers and dentists. Business executives, managers, owners of businesses make up group 2, which is 8% of the total number. The other groups with the percentage of the total number of records which they represent are as follows. group 3—bank clerks, expert accountants, bookkeepers, 6%; group 4—salesmen and insurance agents, 5%, group 5—filling station attendants and store clerks, 1%, group 6—skilled laborers, 14%; group 7—unskilled laborers, 5%, group 8—retired farmers, 1%; group 9—unclassified, 1%.

TABLE 6

Age in months	0—College staff Fr	Mean	Total	Range	1—Doctors, lawyers, etc. Fr	Mean	Total	Range	2—Business executives Fr.	Mean	Total	Range
0-5	1	17.21	17.21	0	1	18 00	18 00	0	2	17 56	35 53	1 17
6-11	6	14 10	84 59	2·19	2	14 49	29 37	0·09	0			
12-17	14	13.32	189.27	2 30	0				0			0
18-23	13	13 07	170 38	1 17	3	12 56	38:48	0 40	1	12 30	12 30	0
24-29	27	12 28	336 54	1 30	5	12 22	57 05	0.56	2	13 30	27 00	1 05
30-35	18	12.11	219.25	2.21	3	12:50	38 31	1 13	3	12 32	37:38	1 22
36-41	22	12.27	274 02	2 31	5	11 59	59 55	1 02	6	12 04	72 27	1.28
42-47	20	11 41	233 53	3.20	1	12 01	12 01	0	4	11 40	46 38	2 11
48-53	25	11 49	295 25	1 57	0				8	11 47	94.20	1 18
54-59	26	11 49	307.28	1 38	2	11 55	23.50	0 56	6	11 31	69 07	2.23
60-71	27	11 37	313 25	2 47	6	11 20	68 04	1 19	5	11 08	55·43	2 30
72-83	29	10 51	314 46	1 16	0				9	10.57	98·34	0 57
84-95	26	10 53	282 57	1·25	0				1	10 32	10 32	0
96-107	21	10 51	227 58	3 15	0				2	10 34	21 10	0 05
108-119	22	10 40	234 57	1 50	2	11 02	22 05	0 40	0			
120-131	18	10.28	188 27	1 16	0				4	10 21	41.25	0 03
132-143	16	10 02	160 41	0 58	4	10 23	41 31	1 38	1	10·34	10·34	0
144-155	10	10 02	100 19	1 15	3	10 41	32 02	0 04	0			0
156-168	3	9 06	27 19	1 15	0				0			0

TABLE 6 (*Continued*)

Age in months	3—Bank clerks, etc Fr	Mean	Total	Range	4—Salesmen, insurance Fr	Mean	Total	Range	5—Store clerks, etc Fr	Mean	Total	Range
0-5	0				0				0			
6-11	1	13 00	13 00	0	0				0			
12-17	3	13 46	41 18	2 22	2	13 38	27 16	0 22	0			
18-23	3	13 28	40 25	0 49	2	13 43	27.27	1 33	0			
24-29	0				0				1	12.23	12.23	0
30-35	3	11 42	35 07	0.47	2	12 01	24 02	0 23	0			
36-41	2	13 04	26 08	0.42	2	12 01	24 02	1 54	1	11 24	11 24	0
42-47	3	12 22	37 08	2 06	3	12 01	36 04	0 45	1	12 21	12 21	0
48-53	3	12 16	36 47	1 40	3	12 00	36 00	0 43	0			
54-59	3	11 13	33 38	1 02	2	11.20	22 40	0-11	0			
60-71	1	11 14	11 14	0	3	11 09	33.27	1 37	0			
72-83	3	10 44	32 11	0 50	3	11 04	33-13	0 15	2	11 22	22 44	0 04
84-95	3	10 46	32 19	0 10	2	10 49	21 37	0	0			
96-107	0				1	10 13	10 13	0	1	11.21	11 21	0
108-119	0				0				1	10 21	10 21	0
120-131	1	9 44	9 44	0	0				0			
132-143	4	10.26	41 47	0 48	1	9 59	9.59	0	0			
144-155	2	9 53	19 48	0 10	3	9 59	29 58	0 51	0			
156-168	0				2	9 32	19 04	0 11	0			

TABLE 6 (*Continued*)

Age in months	6—Skilled laborers Fr	Mean	Total	Range	7—Unskilled laborers Fr	Mean	Total	Range	8—Retired farmers Fr	Mean	Total	Range	9—Unclassified Fr	Mean	Total	Range
0-5	0				0				0				0			
6-11	4	14 08	56·31	3 26	0				0				0			
12-17	2	13·13	26 25	2.25	1	12 46	12 46	0	0				0			
18-23	3	13.23	40 10	1.20	1	13 10	13 10	0	0				0			
24-29	7	12 31	87 38	1 55	2	11 49	23 38	2 01	0				0			
30-35	6	12·14	73 44	1 05	1	12 05	12 05	0	0				2	12.23	24 46	0 11
36-41	8	12 53	103 02	2 37	1	11 55	11 55	0	0				1	14 46	14 46	0
42-47	3	12 10	36 31	1.07	1	10 41	10 41	0	0				0			
48-53	5	11 03	55·16	2 41	1	11 30	11 30	0	0				0			
54-59	4	10 55	43 41	0 15	0				0				0			
60-71	6	11 17	67 43	0 55	1	11·40	11 40	0	0				0			
72-83	3	9 49	29 27	0 59	1	9 18	9 18	0	0				1	10 28	10 28	0
84-95	3	11 08	33.25	1 12	3	11 19	33 55	0.31	0				1	10 51	10 51	0
96-107	12	10 31	126 17	1 41	3	10.44	32 14	1 53	3				0			
108-119	5	10 14	51·10	0 47	4	10 51	43 21	1·17	0	10 30	31 30	0	1	10 28	10.28	0
120-131	11	10 27	115 02	1 53	6	10 08	60 51	2 07	0				0			
132-143	1	10 00	10 00	0	1	10 41	10.41	0	0				1	10 01	10 01	0
144-155	5	10 19	51 35	0 35	3	9 31	28 32	0	0				1	8 51	8·51	0
156-168	3	9 19	27 58	0 14	0				0				1	9.04	9 04	0

From Table 6 it is apparent that there is a trend toward a direct relationship between total sleep and socio-economic status To illustrate, in the 54-59-month age level the mean total sleep is as follows: group 0, 11 hours 49 minutes, group 1, 11 hours 55 minutes, group 2, 11 hours 31 minutes, group 3, 11 hours 13 minutes, group 4, 11 hours 20 minutes, group 5, no records, group 6, 10 hours 55 minutes, groups 7, 8, 9, no records Again in the 96-107-month age level the mean total sleep is as follows: group 0, 10 hours 51 minutes; group 1, no records; group 2, 10 hours 34 minutes, group 3, no records, group 4, 10 hours 13 minutes, group 5, 11 hours 20 minutes, group 6, 10 hours 31 minutes, group 7, 10 hours 44 minutes, group 8, 10 hours 30 minutes, group 9, no records

Table 7 gives the mean total sleep according to age, sex and the presence of others in the room The upper and lower limits are also included in this table. In examining this table it is apparent that for the younger age levels the mean total sleep is the highest when the children slept in a room with other children The mean total sleep is next highest for children sleeping in rooms by themselves, lowest when sleeping in a room with adults. For example, in the 36-41-month age level the mean total sleep for children sleeping in a room with children is 12 hours and 38 minutes; in a room by themselves, 12 hours 36 minutes, and in a room with adults, 12 hours and 21 minutes In the higher age levels a separate sleeping room seems to be conducive to longer sleep. For instance, in the 132-143-month age level the mean total sleep for children sleeping in a room by themselves is 10 hours 31 minutes as compared with 10 hours 17 minutes when in a room with other children and 9 hours 53 minutes when in a room with adults

Table 8, Section A, gives the correlations for the nursery school children for age, total day sleep, introvert-extrovert score, intelligence quotient and total sleep The correlation of —.39[6] between age and total day sleep indicates that as the children grow older the amount of day sleep decreases quite significantly, which of course is to be expected The correlation increases to —.46 when the nap is added to the night sleep The correlation of 61 between total

[6]From Fisher's table of "Significant Values" adapted by Snedecor (22) correlation values above 21 are significant; and values above 27 are highly significant

These figures are for 95 records

TABLE 7

Age in months	Sex	Room by self Fr	Mean	Upper limit	Lower limit	Room with adults Fr	Mean	Upper limit	Lower limit	Room with children Fr	Mean	Upper limit	Lower limit
0-5	Boys	1	18.00	18.00	18.00	1	17.22	17.22	17.22	0			
	Girls	1	18.36	18.36	18.36	1	17.19	17.19	17.19	0			
	Both	2	18.18	18.36	18.00	2	17.20	17.22	17.19	0			
6-11	Boys	4	14.34	14.59	13.24	4	14.00	14.47	13.00	0			
	Girls	0				5	14.07	15.11	10.34	1	12.40	12.40	12.40
	Both	4	14.34	14.59	13.24	9	14.04	15.11	10.34	1	12.40	12.40	12.40
12-17	Boys	3	13.40	15.01	12.31	5	13.17	13.49	13.08	2	14.00	15.41	12.19
	Girls	2	13.47	13.47	13.47	9	13.22	14.26	12.39	2	14.02	14.31	13.23
	Both	5	13.43	15.01	12.31	14	13.20	14.26	12.39	4	14.01	15.41	12.19
18-23	Boys	3	13.31	14.41	12.30	8	13.18	13.48	13.05	0			
	Girls	3	13.01	13.08	12.58	11	13.12	14.00	12.50	2	13.19	14.10	12.27
	Both	6	13.16	14.41	12.30	19	13.14	14.00	12.50	2	13.19	14.10	12.27
24-29	Boys	8	13.27	13.47	12.06	11	11.53	13.10	11.14	5	12.13	12.29	11.30
	Girls	2	13.21	14.03	12.38	12	12.22	12.28	12.19	5	12.43	13.34	12.16
	Both	10	13.26	14.03	12.06	23	12.08	13.10	11.14	10	12.28	13.34	11.30
30-35	Boys	5	12.21	13.26	11.31	10	12.25	13.29	10.50	6	12.06	12.29	11.04
	Girls	3	11.55	12.14	11.14	12	12.18	12.43	11.56	3	12.44	13.01	12.36
	Both	8	12.11	13.26	11.14	22	12.21	13.29	10.50	9	12.19	13.01	11.04
36-41	Boys	3	12.52	12.57	12.40	12	11.55	12.49	11.19	8	12.31	13.54	11.55
	Girls	3	12.17	12.43	11.59	18	12.38	13.14	12.05	3	12.50	12.54	12.43
	Both	6	12.36	12.57	11.59	30	12.21	13.14	11.19	11	12.38	13.54	11.55
42-47	Boys	2	11.41	11.41	11.40	6	11.34	12.28	10.51	8	11.53	12.50	11.38
	Girls	0				16	11.49	14.11	11.05	3	12.20	13.38	11.32
	Both	2	11.41	11.41	11.40	22	11.44	14.11	10.51	11	12.01	13.38	11.32
48-53	Boys	4	11.55	12.02	11.34	9	11.18	12.00	9.40	6	11.55	12.05	10.38
	Girls	6	12.01	12.29	11.43	14	11.41	12.21	10.06	5	12.16	12.53	11.16
	Both	10	11.59	12.29	11.34	23	11.31	12.21	9.40	11	12.04	12.53	10.38

TABLE 7 (*continued*)

Age in months	Sex	Room by self Fr	Mean	Upper limit	Lower limit	Room with adults Fr	mean	Upper limit	Lower limit	Room with children Fr	mean	Upper limit	Lower limit
54-59	Boys	2	11 46	12.29	11 03	12	11 35	11 52	10 46	8	11.22	12 48	10.21
	Girls	3	11.22	11 44	11 07	9	12 03	12 53	11.26	6	11 40	12 03	10·50
	Both	5	11 31	12.29	11 03	21	11 47	12 53	10 46	14	11.29	12 48	10 21
60-71	Boys	5	11·14	11 38	11 01	6	11 55	12 17	10.54	13	11 10	11 40	10 05
	Girls	4	11 52	12 00	11 38	12	11 35	13·13	9 53	8	11.21	12 38	10 46
	Both	9	11 31	12.00	11 01	18	11.41	13 13	9.53	21	11 14	12 38	10 05
72-83	Boys	5	11 16	11 24	11 14	15	10 52	11 43	9 18	10	10 34	11.24	9 58
	Girls	3	10 58	11 34	10 39	8	11 05	11.24	10·33	10	10 53	11 03	10 17
	Both	8	11 09	11 34	10 39	23	10.56	11 43	9.18	20	10 44	11.24	9 58
84-95	Boys	3	10 45	11·10	10 23	9	10.43	11 17	10.11	7	10 55	11.13	10.29
	Girls	8	10 44	11 14	10 00	5	11 14	11 51	10 46	7	11 10	11 40	10 53
	Both	11	10 44	11 14	10 00	14	10 55	11:51	10 11	14	11 02	11 40	10.29
96-107	Boys	3	10 26	11 08	9 56	11	10 32	10 42	9·54	9	10:34	10 52	10.26
	Girls	4	11 48	15 34	10 22	7	10 27	11.21	9 53	9	10 55	11·34	10 14
	Both	7	11 13	15 34	9 56	18	10 29	11 21	9 53	18	10 44	11.34	10 14
108-119	Boys	4	10 20	10 46	9 31	2	10 35	11.21	10 00	7	10 42	11 38	10 19
	Girls	6	10 47	11 27	10 32	6	10 28	10 44	10 04	10	10 44	11 14	10 20
	Both	10	10 37	11.27	9 31	8	10 31	11 21	10 00	17	10 43	11 38	10 19
120-131	Boys	0				4	10 49	11 31	10 00	10	10 18	10 50	10 00
	Girls	7	10.27	10 49	10 10	9	10 14	10 50	9 38	10	10 24	11 04	10 00
	Both	7	10 27	10 49	10 10	13	10.25	11 31	9·38	20	10.21	11 04	10 00
132-143	Boys	2	10 01	10 05	9 56	4	10 01	10 21	9 37	5	10 11	10 34	9 49
	Girls	5	10 43	11 16	10 16	8	9 50	10 06	9 32	5	10:23	10 41	10 00
	Both	7	10 31	11 16	9 56	12	9 53	10 21	9 32	10	10 17	10·41	9 49
144-155	Boys	6	9 52	9 59	9 50	3	9 37	9 41	9.23	8	10 17	10 24	9 39
	Girls	5	10 07	10 31	9 33	1	8 55	8 55	8 55	4	10 25	10 38	9 57
	Both	11	9 57	10 31	9 33	4	9.26	9 41	8 55	12	10.20	10.38	9 39
156-168	Boys	2	8 56	9 37	8·16	1	9.27	9.27	9.27	2	9 24	9 24	9.24
	Girls	0				1	9 43	9 43	9 43	3	9 11	9 12	9·10
	Both	2	8 56	9 37	8 16	2	9 34	9 43	9.27	5	9 16	9 24	9 10

TABLE 8
Section A
CORRELATIONS FOR NURSERY SCHOOL CHILDREN

	Total day sleep	Introvert-Extrovert score	I Q	Total sleep
Age	— 39	.11	43	— 46
Total day sleep		— 07	— 15	61
Introvert-Extrovert score			—.10	— 10
I Q.				— 26
95 records				

TABLE 8
Section B
CORRELATIONS FOR GRADE SCHOOL CHILDREN

	School average	I Q	Total sleep
Age	03	— 03	— 50
School average		27	06
I Q			02
244 records			

TABLE 8
Section C
MEANS FOR NURSERY SCHOOL CHILDREN

	Means	S D
Age in months	41 74	11 51
Total minutes day sleep per week	578 11	225.64
Introvert-Extrovert score	66 42	16 10
I Q	114 59	15 45
Total minutes sleep night and day per week	5113 26	320 32

TABLE 8
Section D
MEANS FOR GRADE SCHOOL CHILDREN

	Means	S D
Age in months	99 74	25 08
School average	88 76	4 13
I Q	111.33	11 68
Total minutes sleep night and day per week	4545 86	323 65

day sleep and total sleep shows that day sleep increases as night sleep increases. Of course day sleep is included in total sleep, so that it contributes to the correlation value as being self-correlated. This, however, does not detract from the significance of the correlation. The correlation of .43 between I.Q. and age seems rather astonishing at first but may be explained on the basis that while at nursery school the I.Q. of the children increases with successive testings and as the *children increase in age.* *Development during attendance at the* nursery school is proportionally quite rapid because of the age ranges involved. From the correlation of —.26 between I.Q. and sleep it is apparent that the more intelligent children sleep less. This is in accordance with White's (23) findings.

The other correlations are not significant. There is a lack of relationship between age and introvert-extrovert score, between total day sleep and introvert-extrovert score, between total day sleep and I.Q., between introvert-extrovert score and I.Q., and between introvert-extrovert score and total sleep. The multiple correlation is .66.

Table 8, Section B, gives the correlations for the school children. The correlation of —.50[7] between age and total sleep indicates that as the children grow older they sleep less. School age correlates .27 with I.Q. No significant relationship appears between school average and total sleep nor between I.Q. and total sleep. The multiple correlation is .51.

The means for the nursery school children for age, introvert-extrovert score, I.Q., total day sleep and total sleep are given in Table 8, Section C. It appears that the group was superior in intelligence and somewhat more extroverted than introverted.

In Table 8, Section D, are given the means for the school children for age, school average, I.Q. and total sleep. This group also gives evidence of superiority in intelligence with a school average that likewise runs high.

Figure 1 gives a summary of the results of this study as compared with the findings of other investigators. The figures from this study closely approximate the data of Foster, Goodenough and Anderson

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[7]From Fisher's table of "Significant Values" adapted by Snedecor (22) correlation values above .14 are significant, and values above .18 are highly significant.

These figures are for 244 records.

6 Children sleeping in a room with other children or by themselves slept longer than those in a room with adults

7 The nursery school children show a high positive correlation between total day sleep and total sleep and between age and I.Q There is a significant negative correlation between total sleep and I Q There is no correlation between total sleep and an introvert-extrovert score

8 For the grade school children there is no correlation between total sleep and I Q and between total sleep and the school average

9 Both groups show a high negative correlation between age and total sleep.

An extension of the analysis of our data promises further interesting results Analysis of other phases in problems of children's sleep is now being undertaken, and will be presented presently

Summary

Data regarding the habits and amounts of sleep of children from two months to fourteen years of age were secured by means of a sleep record In the final analysis 644 records from 409 children kept for a period of one week beginning July 14, 1930, November 2, 1930, February 1, 1931, and May 3, 1931 were used The data were analyzed to determine the following trends (1) children actually sleep less than is prescribed by medical specialists and by psychologists, (2) slight sex differences reveal that girls sleep longer than boys, (3) night sleep is longest in the fall and winter, (4) children who sleep relatively longer during day-time sleep relatively longer during night, (5) there is a slight significant relationship between amount of sleep and socio-economic status, (6) optimum sleeping conditions as regards people in the room occur when the child sleeps in a room with children or by himself, (7) as would be expected, there is a high negative correlation between age and total sleep Further analysis of the records promises interesting additional trends.

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UNE ÉTUDE ANALYTIQUE DU SOMMEIL DES ENFANTS

(Résumé)

Au moyen de la notation du sommeil faite par les mères on a obtenu des données à l'égard des habitudes et les quantités du sommeil des enfants âgés de deux mois à quartorze ans. Les enfants appartenaient à des familles de divers niveaux socio-économiques dans une ville d'environ 10,000 habitants. Dans l'analyse finale on a employé 644 notations de 409 enfants faites pendant huit jours en juillet, novembre, février et mai. On a analysé les données pour determiner les tendances suivantes: (1) les enfants dorment vraiment moins de temps que celui ordonné par les médecins spécialistes et les psychologues, (2) les petites differences de sexe montrent que les filles dorment plus de temps que les garçons, (3) le sommeil pendant la nuit est le plus long en automne et en hiver, (4) les enfants qui dorment relativement plus de temps pendant la journée, dorment relativement plus de temps la nuit, (5) il existe une petite relation significante entre la quantité du sommeil et l'état socio-économique; (6) les meilleures conditions du sommeil à l'égard des personnes dans la chambre se trouvent quand l'enfant dort dans une chambre avec d'autres enfants ou seul; (7) les enfants de l'ecole maternelle montrent une corrélation négative significante entre le sommeil total et le Q.I., (8) les enfants de l'école élémentaire ne montrent nulle corrélation entre le sommeil total et le Q.I. et entre le sommeil total et le sommeil moyen de lécole (9) comme on le croirait, il y a une corrélation négative élevée entre l'âge et le sommeil total.

ERWIN

EINE ANALYTISCHE UNTERSUCHUNG DES SCHLAFES BEI KINDERN

(Referat)

Daten uber die Gewohnheiten und Menge des Schlafes bei Kindern von zwei Monaten bis vierzehn Jahren wurden durch ein Schlafprotokoll erhalten, das von den Muttern gefuhrt wurde. Die Kinder stammten aus verschiedenen sozial wirtschaftlichen Schichten einer Stadt von ungefahr 10,000 Einwohnern. In der endgultigen Untersuchung wurden 644 Protokolle von 409 Kindern angewandt, die uber einen Zeitraum von einer Woche wahrend der Monate von Juli, November, Februar, und Mai gefuhrt wurden. Die Ergebnisse wurden untersucht, um die folgenden Neigungen zu bestimmen: (1) Kinder schlafen tatsachlich weniger als die Mediziner und Psychologen vorschreiben, (2) kleine Geschlechtsunterschiede zeigen, dass Madchen langer schlafen als Knaben, (3) der Nachtschlaf ist am langsten im Herbst und Winter, (4) Kinder, welche verhaltnismassig langer wahrend des Tages schlafen, schlafen verhaltnissmassig langer wahrend der Nacht, (5) es gab ein kleines positives, bedeutsames Verhaltnis zwischen der Menge des Schlafes und der sozial-wirtschaftlichen Lage, (6) die gunstigsten Schlafzustande bezuglich der Menschen im Zimmer finden dann statt, wenn das Kind in einem Zimmer mit anderen Kindern oder allein schlaft, (7) Kinderstubenkinder zeigen eine bedeutsame negativ Korrelation zwischen dem Gesamtschlaf und dem I.Q., (8) Schulkinder weisen keine Korrelation zwischen dem Gesamtschlaf und zwischen dem Gesamtschlaf und den durchschnittlichen Schulzeugnissen auf; (9) wie zu erwarten ist, gab es eine hohe negative Korrelation zwischen dem Alter und dem Gesamtschlaf.

ERWIN

THE EFFECT OF FASTING ON THE EATING-BEHAVIOR OF RATS*

From the Psychological Laboratory of Harvard University

W A Bousfield and M. H Elliott

Hunger, as one of the fundamental sources of animal motivation, has received a great deal of attention from the comparative psychologists The hunger-drive has been defined in various ways but usually means the complex of organic conditions produced in the organism by deprivation of food, Basic to the concept of drive is the idea that drive is something which varies in strength Most of the studies of drive have been concerned with attempts to correlate measurable aspects of behavior with extent of deprivation (in the hunger-drive, with either the length of fast or the amount of deficiency of the ration).

One of the evident difficulties in studies of the strength of drive arises from the fact that each experimenter is forced to select some limited phase of the behavior and to use the frequency, duration, or intensity of this particular bit of behavior as a measure of the strength of the drive A satisfactory account of the strength of the drive cannot be given by such correlations between extent of deprivation and occurrence of isolated phases of behavior Leuba (7), in a criticism of Warden's comparisons of the relative strengths of various drives, shows the arbitrary nature of some of the measures which have been used and points out the fact that by selecting other measures one may obtain entirely different results on the strengths of different drives.

Each of the fundamental drives probably affects not only the pertinent associated reflexes, such as eating and sucking in hunger, but it affects the whole behavior of the organism Thus Carlson (4) has demonstrated an increase in the patellar reflex with hunger. Langfeld (6) and Rogers (9) have presented evidence which suggests that sensory acuity is increased with hunger Richter (8), Wada (12), and many others have shown the relationship between gross general activity and hunger. From a review of such evidence one is tempted to conclude that a widespread general facilitation constitutes the very essence of the drive-condition But this conclusion

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must not be accepted too hastily. Sherrington (10) and others have shown the close relationship between facilitation and inhibition. Facilitation of certain processes often if not always means the inhibition of other processes. Certainly a drive does not affect all action-systems equally The determination of the patterns of facilitation and inhibition for each drive is then essential for the further understanding of some of the problems of motivation.

A review of previous studies of the hunger-drive indicates that most of the experimenters have selected some aspect of the initial restlessness [Woodworth's "preparatory reactions" (13)] as an index of the strength of drive It follows from this that one very important group of reflexes associated with and affected by the hunger-drive has been neglected. With a few exceptions, e g, Bayer (1), Bousfield (2), Skinner (11), the experimenters have not dealt with the *consummatory* reflexes. The present study approaches the general subject of the hunger-drive by selecting for investigation certain aspects of the actual eating. More specifically, the procedure was planned to determine the effect of various periods of fasting on the rate of eating and on the amount of food eaten. The results to be reported were obtained from two separate experiments.

Experiment I

Five groups of adult Wistar albino rats were used in this experiment. Group A comprised 6 males, Group B, 5 males, and Groups C, D, and E, 6 females each Purina Dog Chow was used as the standard food. All rats were allowed at least three weeks to become adjusted to a regular spacing of the periods of feeding Every day at 9·30 A M each group was removed from its home-cage and placed in a clean feeding-cage containing a liberal supply of the standard food. At 10 30 A M. the rats were returned to the home cages. Following the specified period of training the food was weighed before and after feeding, the difference being recorded as the amount consumed by the group After at least a week during which daily records were obtained of the food eaten the first delay of 3½ hours in the feeding time was introduced, that is, the rats were fed from 1 P.M to 2 P M. The amount of food eaten by each group was determined as before Following the delay the groups were placed again on the regular schedule of feeding for at least a full week before another delay was made. In addition to the 3½-

hour delay there were delays of 12, 24, and 48 hours introduced in random order Water was available to the animals at all times When the animals were returned to the regular schedule of feeding after the longer delays it was observed that the amounts of food consumed remained relatively low for 2 or 3 days and that a marked irregularity persisted for varying intervals of time In some instances a week elapsed before a return to normal. Additional delays were not imposed until the amount of food consumed by a group had been maintained at the normal level for at least a week In the case of the 48-hour delay as many as 17 days were sometimes necessary before another delay could be imposed

The essential data for this experiment are presented in Table 1. The figures for the controls (listed under C) represent the average daily consumption of food per rat for the 4 days preceding the designated delay The figures for the delays (listed under D) represent the average amount of food per rat for the delayed feeding. The trend of these figures is clearer in the ratios D/C which indicate the fractional variations from the controls.

It may be readily observed from the data that a delay in feeding, *that it, a longer fast, is correlated with a decrease in the amount of* food eaten There is, however, a large variability in the figures and the relative decrease in consumption of food is not uniform The writers, at this point, venture the suggestion that the lack of uniformity in the decrease which is most marked in the comparative values of the figures for the 12-hour delays may be due to the spacing of the periods of feeding in relation to the established 24-hour rhythm.

Experiment II

The results of the previous experiment give only a rough indication of the changes in behavior towards food which are correlated with increase in the period of fasting. In order to obtain more detailed information a technique was devised for securing continuous individual records of the eating responses Cylindrically shaped pellets of uniform size, weighing approximately ¼ gram each, were made from the standard food These pellets were fed to the animals in a device arranged to give step-wise kymographic records, each step representing the removal by the animal of one of the pellets from a space at the lower end of a glass tube This space was only slightly in excess of the length of the pellets, thus allowing the removal of

TABLE 1

COMPARISON OF THE AVERAGE AMOUNTS OF FOOD CONSUMED (PER RAT IN GRAMS) DURING THE CONTROL SERIES OF FEEDINGS *C* WITH THE AVERAGE AMOUNTS CONSUMED DURING THE SPECIFIED DELAYED FEEDINGS *D*

Hours delay	Group A (6 rats)			Group B (5 rats)			Group C (6 rats)		
	C	*D*	*D/C*	*C*	*D*	*D/C*	*C*	*D*	*D/C*
	11.7	12.7	1.085	11.0	8.8	.800	7.9	8.7	1.101
3½	12.3	11.8	.959	10.8	11.0	1.019	8.4	7.3	.869
	10.7	9.7	.907	8.6	8.8	1.023			
	11.8	11.2	.949	10.9	9.2	.844	8.9	7.2	.809
12	12.6	12.5	.992	11.4	9.8	.860	9.4	8.2	.872
	12.8	12.2	.953	12.1	9.0	.744	9.4	7.8	.830
	9.6	9.8	1.021	9.3	8.6	.925	7.3	6.5	.890
24	10.9	10.2	.936	10.4	8.4	.808	8.2	6.3	.768
	11.4	10.3	.904	10.3	7.6	.738	9.0	6.7	.744
	13.1	10.3	.786	10.7	7.6	.710	9.2	6.3	.685
48	11.2	8.8	.786	9.5	6.4	.674	8.3	6.2	.747
	12.4	9.8	.790	10.5	7.4	.705	9.3	5.8	.624

Hours delay	Group D (6 rats)			Group E (6 rats)			Averages for all groups		
	C	*D*	*D/C*	*C*	*D*	*D/C*	*C*	*D*	*D/C*
	8.8	8.7	.989	9.3	8.7	.935			
3½	8.8	9.5	1.080	8.8	8.2	.932			
	8.2	8.0	.976				9.6	9.4	.975
	9.8	8.0	.816	9.9	8.3	.838			
12	10.5	8.5	.810	10.1	8.5	.842			
	10.2	7.8	.765	10.6	8.2	.774	10.7	9.1	.847
	8.5	7.8	.918	8.4	8.0	.952			
24	9.0	7.8	.867	8.5	8.0	.941			
	9.3	7.2	.774	9.7	7.2	.742	9.3	8.0	.862
	9.5	8.2	.863	10.4	7.5	.721			
48	8.8	7.0	.795	8.9	6.3	.708			
	10.0	7.7	.770	9.2	7.2	.783	10.1	7.5	.743

but one piece of food at a time The movement of the descending column of food was transmitted to the writing lever of the kymograph by a simple mechanical system involving a weight and reducing pulleys. In this way highly uniform eating-curves were obtained from about 4 out of every 5 rats used Only those animals were discarded which developed the habit of storing up food, i.e., of removing a second pellet before the first had been consumed. During the period of eating in the apparatus the rats occupied individual cages each of which contained a separate feeding unit and a supply of water.

A group of seven rats was selected from those used in the previous experiment. These animals were continued on the same schedule of daily feeding The procedure involved first the obtaining of control records, for which the animals were simply placed in the recording apparatus instead of being removed to the common cages in which they were ordinarily fed Delays of 1, 2, and 3 days were alternated with the controls. Since the control records were taken after the usual 24-hour fast it is obvious that a 3-day delay means a 4-day fast In order to make the records of eating as complete as possible the rats were allowed in all cases to remain in the apparatus for at least 130 minutes Figure 1 gives a sample record, actually

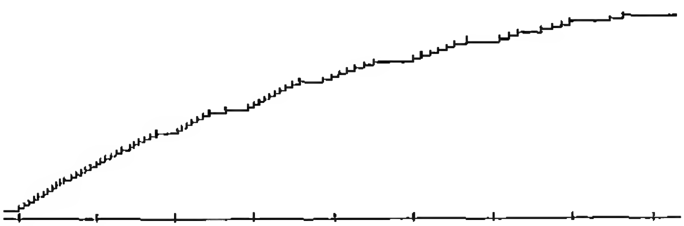

FIGURE 1

RECORD OF RAT FOR THE FIRST CONTROL PERIOD OF EATING
Each step on the curve represents the removal by the rat of a pellet of food from the recording apparatus The time-line is punctuated in units of 16 25 minutes

the first control record of Rat A The time-line is punctuated in intervals of 16.25 minutes. One may readily determine by projecting up from the time-line that at the end of the 1st interval the rat has eaten 16 pellets, at the 2nd, 28, at the 3rd, 37, at the 4th, 48, at the 5th, 53, at the 6th, 60, at the 7th, 67, and at the

8th, 69. The amounts of food eaten by each animal at the end of the 1st, 2nd, 4th, 6th, and last measured intervals are presented in Table 2. It may be seen that the decrease in rate of eating tends to hold regardless of the length of the period of eating chosen.

A further index of the change in the rate of eating was secured by measuring on each record the times between the successive steps, that is, the times required for the eating of successive pellets On the basis of these measurements, frequency distributions were made from which were calculated the average times and standard deviations. The ratios of the standard deviations to the averages multiplied by 100 furnish the coefficients of variation Both the averages and the coefficients are presented in Table 3

Inasmuch as the rate of eating progressively decreases during the period of eating and the measures obtained from the later portions of the eating-curves are relatively more variable, the indices presented in Table 3 are necessarily crude Nevertheless the figures for the average rates of eating are substantially in accord with the data of Tables 1 and 2 The tendency towards a decrease in the coefficient of variability for the delayed records in spite of the increase in the average times for eating individual pellets is interesting since the figures furnish an indication of another aspect of drive, namely, the tendency towards stability or constancy of behavior

Conclusions and Discussion

Both of the experiments indicate that, with the particular food used, the amount of food eaten decreases with an increase in the length of the fast Experiment 1 is concerned only with the average amount of food eaten and gives but little information about the rate of eating One might well expect that after a 48-hour fast a rat would begin by eating more rapidly than after a 24-hour fast even though it could not eat an equal amount of food Experiment 2 was planned to throw further light on this question. It was found that *with the longer fasts and smaller amounts of food eaten there* was a correspondingly slower rate of eating Furthermore this slower rate is evident at all stages of the eating curve (Table 2) Carlson's studies (4) have provided an obvious explanation for the decrease in amount of food eaten after the longer fast There are definite changes in the tonicity of the stomach which should have the effect of reducing the capacity after fasting

TABLE 2

COMPARISON OF THE NUMBER OF PELLETS OF FOOD CONSUMED BY INDIVIDUAL RATS AT VARIOUS POINTS IN CONTROL AND DELAYED RECORDS

The last measured intervals indicate the terminal units of 16.25 minutes which fall on the records

	Number of pellets eaten after 16.25 min.	32.50 min.	65.00 min.	97.50 min.	Last measured interval
Rat A					
C	16	28	48	60	69 (130.00 min.)
D—1 day	13	27	47		58 (97.50 min.)
C	17	31	53	66	73 (130.00 min.)
D—2 days	15	26	41	55	60 (113.75 min.)
C	17	33	59	73	79 (113.75 min.)
D—3 days	13	23	39	48	51 (113.75 min.)
Rat B					
C	21	36	60		69 (81.25 min.)
D—1 day	20	34	53		58 (81.25 min.)
C	21	37	65		70 (81.25 min.)
D—2 days	—	—	—	—	—
C	21	40	67	78	80 (113.75 min.)
D—3 days	17	30	50		57 (97.50 min.)
Rat C					
C	16	24	41	49	58 (113.75 mni.)
D—1 day	15	31	54		59 (81.25 min.)
C	20	37	61		72 (97.50 min.)
D—2 days	17	30	48	55	59 (113.75 min.)
C	22	40	66		73 (81.25 min.)
D—3 days	13	25	41		50 (97.50 min.)
Rat D					
C	18	33	59		66 (81.25 min.)
D—1 day	17	29	51	62	66 (113.75 min.)
C	17	31	52	60	63 (113.75 min.)
D—2 days	15	26	43	54	59 (113.75 min.)
C	22	39			67 (65.00 min.)
D—3 days	13	27	44		53 (97.50 min.)
Rat F					
C	17	30	51	55	62 (113.75 min.)
D—1 day	13	22	39	51	53 (113.75 min.)
C	15	27	48		57 (81.25 min.)
D—2 days	14	22	38	45	49 (130.00 min.)
C	16	27	41		53 (97.50 min.)
D—3 days	13	22	31	37	41 (130.00 min.)
Rat G					
C	17	33	60		76 (97.50 min.)
D—1 day	16	29	52	67	78 (130.00 min.)
C	19	35	66		83 (97.50 min.)
D—2 days	13	24	42	51	59 (130.00 min.)
C	14	29	50	66	71 (113.75 min.)
D—3 days	11	21	35	42	46 (113.75 min.)
Rat H					
C	12	23			41 (65.00 min.)
D—1 day	10	18	31	41	46 (130.00 min.)
C	12	25	43	55	56 (113.75 min.)
D—2 days	9	17	30	37	41 (113.75 min.)
C	13	24	40	50	57 (130.00 min.)
D—3 days	—	—	—	—	—

TABLE 3

COMPARISON OF THE AVERAGE EATING-TIMES FOR PELLETS, AND COEFFICIENTS OF VARIATION OF THESE TIMES DETERMINED FOR THE CONTROL AND DELAYED RECORDS

The averages are based on units of 0.406 minutes

	Rat A		Rat B		Rat C		Rat D	
	Av	Coeff.	Av	Coeff	Av	Coeff	Av	Coeff
C	4.46	85.7	3.57	72.3	5.33	187.3	3.79	94.4
D—1 day	4.20	72.7	3.82	89.0	3.44	88.9	4.83	84.9
C	4.53	99.6	3.15	83.8	3.66	110.4	5.08	157.3
D—2 days	5.38	68.0			5.27	84.4	5.57	61.9
C	3.90	88.4	3.63	187.5	3.07	157.9	2.83	53.0
D—3 days	5.98	68.2	4.60	91.8	4.82	75.8	5.14	71.0
	Rat F		**Rat G**		**Rat H**		**Group**	
	Av	Coeff.	Av.	Coeff	Av	Coeff	Av	Coeff
C	5.02	161.7	3.67	63.8	3.48	60.4	4.19	103.7
D—1 day	5.91	86.7	4.29	55.2	7.36	55.1	4.84	76.1
C	3.64	84.0	3.21	79.8	5.54	75.7	4.12	98.7
D—2 days	6.67	79.2	5.93	57.7	8.42	59.6	6.21	68.5
C	4.80	72.0	4.30	60.0	5.98	66.8	4.07	97.9
D—3 days	7.88	97.2	6.52	66.0			5.82	78.3

The two results indicated above, the smaller amount of food eaten and the slower rate of eating with longer fasts, appear to be opposed to the results of observations on the behavior of hungry animals One ordinarily supposes that animals with longer fasts are "hungrier" and that this increased drive manifests itself in the behavior towards food. The question arises as to how the behavior of the animal after a 48-hour fast differs from the behavior after a 24-hour fast Less food is eaten and the food is eaten *more slowly after the longer fast* These features of the behavior however would not lead one to say that the 48-hour animal is "hungrier" or more voracious What then are the aspects of the behavior towards food which do increase with the longer fasts and which lead the observer to attribute to animals under such conditions a greater degree of motivation?

A partial answer to this question is furnished by the coefficients of variation obtained from the data in Experiment II (Table 3). The *animals with the longer fasts eat more steadily and more persistently* The times required to eat the pellets are relatively more constant These animals cannot eat so much nor so rapidly as animals with shorter fasts but it may be said that they tend more strictly to the business of eating The smaller variability shown here may be related to similar findings on the relation of hunger to variability of

performance in the multiple-choice apparatus (Elliott, 5). A second answer to the question posed above may be indicated here although no evidence for it is given in the present paper. It has been shown experimentally by Bousfield (3) and supported by a great deal of observational evidence that with longer fasts animals will eat a much greater variety of objects.

The data given on the amount of food eaten indicate a gradual decrease with lengthening of the period of fasting. The shape of the curve of decrease as a function of the length of the fast is still indeterminate. The evidence is not at present conclusive but seems to be consistent with the reasonable inference that the decrease is most rapid in the earlier stages of fasting. Comparison of the 3½-hour, 12-hour, and 24-hour delays suggests that there is also a rhythmic effect within the daily periods. It is the present belief of the writers that the measurements after 24, 48, 72, and 96 hours of fasting represent maxima. The animals tested at these times are eating on their rhythm, at 9:30 A.M., the accustomed feeding time. Richter (8) has demonstrated the persistence of such rhythms after long deprivation of food. It is certain that the animals are more active at this time and presumably their stomachs are contracting more vigorously and are thus in a better condition to receive and digest food. If these speculations are correct measurements should show more food eaten after a 48-hour fast than say after 42 or 54 hours. This hypothesis is now being tested.

As a result of the experiments here reported and of further experiments which are being conducted, the writers are inclined to make certain suggestions with regard to the control of the hunger-drive in animal learning experiments. In order to ensure maximal positive behavior towards food in the experimental situation the experimenter should as a preliminary step establish a definite eating rhythm by feeding the animals at that time of day at which they are to be experimented upon. If the experimenter is interested in maintaining a fairly constant state of motivation from day to day, the establishment of a definite rhythm of eating will enable him to do this with the least number of complications. After the rhythm is established the food consumption need not be controlled by weighing either the food or the animals. It should be sufficient to allow the animals free access to food for a definite time, probably about 90 minutes. Animals eating on the rhythm will to a very large

extent control their own food consumption. Fortuitous changes in the needs of the animals, such as those caused by changes in the temperature, will be compensated for by changes in the rate of eating during the period of feeding. It is the belief of the writers, and a certain amount of evidence has been accumulated to support this belief, that the condition of the animals will be maintained at a more nearly constant level by this procedure than by the usual procedures of feeding a measured amount of food, feeding to maintain a constant body weight, or feeding to obtain some definite increase in body weight.

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L'EFFET DU JEÛNE SUR LE COMPORTEMENT DES RATS PENDANT L'ALIMENTATION

(Resumé)

Expérience 1

On a donné de la nourriture à des rats selon un programme quotidien régulier et l'on a détermine la quantité moyenne de nourriture prise. A des intervalles irreguliers on a retardé l'heure de l'alimentation de 3½, de 12, de 24, ou de 48 heures et on a mesuré encore la quantite de nourriture prise. La quantite de nourriture prise a varié inversement avec la longueur du retard.

Expérience 2

Des rats choisis pour une étude plus intensive du comportement pendant l'alimentation ont ete placés dans un appareil qui a fourni des enregistrements kymographiques de la quantité de nourriture prise et de la vitesse de l'alimentation. On a introduit des retards de 1, de 2, et de 3 jours. Avec les plus longues périodes de jeûne les animaux ont pris non seulement moins de nourriture mais aussi ont mangé plus lentement. Des mesures des temps mis à prendre les petites boules individuelles de nourriture ont montré que les rats qui ont subi les plus longs jeûnes ont eté relativement plus stables dans leur comportement.

On suggere que l'observateur attribue beaucoup plus de mobiles à un animal après un plus long jeûne, malgré la plus petite quantité de nourriture prise et la moins grande vitesse de l'alimentation, à cause de la plus grande constance de la vitesse de l'alimentation et aussi parce qu'une beaucoup plus grande variété d'objets seront acceptes comme nourriture.

BOUSFIELD ET ELLIOTT

DIE WIRKUNG DES FASTENS AUF DAS FRESSVERHALTEN BEI RATTEN

(Referat)

Experiment 1

Ratten wurden regelmassig taglich gefuttert, und die Durchschnittsverzehrung des Futters wurde festgestellt. In unregelmassigen Abstanden wurde das Futtern 3½, 12, 24, oder 48 Stunden verzogert und die Verzehrung des Futters wurde nochmals gemessen. Die Menge des Futters, die gefressen wurde, varierte umgekehrt mit der Lange der Verzogerung.

Experiment 2

Ratten, welche zur intensiveren Untersuchung des Fressverhaltens ausgewahlt wurden, wurden in einen Apparat gestellt, der eine kymographische Aufzeichnung der Menge des verzehrten Futters und der Schnelligkeit des Fressens gab. Verzogerungen von 1, 2, und 3 Tagen wurden gebraucht. Bei den grosseren Abstanden des Fastens frassen die Tiere nicht nur weniger, sondern auch langsamer. Messungen der Zeitraume des Fressens einzelner Stucke Futter zeigten, dass die Ratten bei dem langeren Fasten verhaltnismassig stabiler in ihrem Verhalten waren.

Es wird vorgeschlagen, dass der Beobachter einen grosseren Grad der Motivierung dem Tier nach einem langeren Fasten zuschreibt, trotz der verminderten Verzehrung des Futters und der langsameren Schnelligkeit des Fressens wegen der grosseren Bestandigkeit der Schnelligkeit des Fressens und auch wegen der Tatsache, dass eine weit grossere Verschiedenheit der Objekte als Futter angenommen wird.

BOUSFIELD UND ELLIOTT

CONTRIBUTIONS TO THE PROBLEMS OF INSTINCT IN TEXTBOOKS ON EDUCATIONAL PSYCHOLOGY*

From the Department of Psychology of Stanford University

HAROLD S. WYNDHAM

Forty years ago, three years after James had given to psychology the famous figure of the "stream of consciousness," students of educational psychology were learning from a new edition of Compayré that "Education has a twofold purpose to store the mind with the greatest possible amount of knowledge or truth, and, at the same time, to form the mind itself, to develop the faculties of the intelligence" (2, p 33) Such teaching is characteristic of much that has happened in educational psychology in the years that have followed Especially in the texts designed for class work with students, there has been a lag behind even the published work in the field of pure psychology This tendency for teaching to follow at some distance behind research is ascribed by some to that mixture of caution and inertia which men call conservatism, but it has also been caused, in part, by the complexity and specialization of fields of study and the increasingly expert nature of modern experimental techniques

The problem of instinct and its treatment are an outstanding example of this lack of coordination in the several fields of research and teaching. In 1919, for example, Dunlap (4) raised the question "Are There Any Instincts?" and in 1921 Kuo (7) suggested "Giving up Instincts", in 1927 Sandiford (14, p. 121) wrote: "It is very probable that Psychology will have to give up instincts, . . ." Thus in 1933 some students are pondering as a possibility an event which has actually taken place in certain psychological circles. The remainder seem to be largely unaware of any vital cause for debate!

It is true that the anomalies of the situation may easily be overstated The teaching of elementary educational psychology would be a hazardous adventure if it were immediately sensitive to every change of the psychological weather-cock Students would indeed be "carried about with every wind of doctrine" On the other hand, it must be confessed that research psychologists have

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not always readily grasped the significance of discoveries and contributions made outside their immediate field. Yet, in the last analysis, it does seem true that in regard to this problem of the nature and function of instinct textbooks in educational psychology have tended to perpetuate doctrines whose assumptions have been called into question by later research and to perpetuate these doctrines without adequate examination of their implications for a consistent exposition of psychological theory.

In Table 1, a review is attempted of the chief contributions in the three areas which are involved, namely, research in psychology and biology, the teaching in these fields, and the teaching of educational psychology While these areas overlap at times—the author of a textbook not necessarily being a stranger to research—these three areas have been indicated, respectively, by the reports of research in the periodical literature, by published works in pure psychology, in physiology, and biology; and by the chief textbooks in educational psychology. This separation into three areas is more easily justified in regard to the study of instinct than in connection with some other psychological problems, since many of the most challenging contributions in this field have been made by biologists, neurologists, and pathologists, to whose specialized fields of study and peculiar research techniques the educational psychologist must always remain a comparative stranger.

Especially in regard to research, no attempt has been made to compile an exhaustive list, but contributions have been selected which seem to have indicated fresh sources of data or new angles of approach to the central problem. In general, further contributions along the same line by the same worker have not been included

An examination of the resulting table serves not only to demonstrate the diversity of sources which have been tapped in the investigation of this problem, but also bears out what has been said above in regard to the delay which seems inevitably to take place between the publication of research results and their incorporation and application in the teaching of educational psychology. It is of interest, further, to compare texts in educational psychology with which one has long been familiar with the background in other fields of psychology out of which they sprang.

A more detailed "horizontal" examination of the interrelation of these areas would be both interesting and profitable, but it is pro-

TABLE 1
CONTRIBUTIONS TO THE PROBLEMS OF INSTINCT AND EMOTION

Year	Educational text	General psychology	Periodical literature, etc
1890		James. *Principles*	Loeb *Der Heliotropisms die Thiere*
'91		Morgan *Animal Life and Intelligence*	
'93	Compayré		
'94		Morgan *Comparative Psychology*	Shinn *Notes on the Development of a Child*
'96	Morgan	Groos: *Play of Animals*	
'97			Thorndike *Animal Intelligence* (and articles during succeeding years)
'98		Stout *Manual*	
'99		Groos: *Play of Man*	
1900		Morgan. *Animal Behaviour*	
'02		Pavlov: *Digestive Glands* (English ed)	
'03	Judd		Hall's articles in *Ped Sem*
'04		Hall. *Adolescerce*	Stern's vocabulary studies
'05	Bagley	Peckhams *Wasps*	
'06	Horne	Jennings. *Behavior of Lower Organisms*	
		Sherrington *Integrative Action*	- - -
'08		McDougall *Social Psychology*	
'09	Münsterberg		Clark University Meeting, Freud
'10			*Brit J Psychol*, symposium
'11	Welton		Head re thalamus in *Brain*
	Pyle		Wells and Forbes on psychogalvanometer
'12	Dumville		
'13	Colvin and Bagley	Verworn *Irritability*	
	Thorndike		
'14		Watson: *Behavior*	Feleky Expression of Emotions (*Psychol Rev*)
		Cannon *Bodily Changes*	
'15		Crile *Origin and Nature of Emotions*	Kendall *Constitution of Thyroxin*
'16		Jung. *Psychology of the Unconscious*	
		Schafer: *Endocrine Organs*	

TABLE 1 (*continued*)

'17	Gordon		Moore Emotions (*Amer J Psychol*) Lashley's localization studies Watson and Morgan Emotions (*Amer J Psychol*)
'18		Woodworth. *Dynamic Psychology*	
'19	Starch		Dunlap Are There Any Instincts? (*J. Abn Psychol*)
'20		Freud *General Introduction*	Rayner and Watson Conditioned Emotional Reactions (*Scient Mo*) Tolman Instinct and Purpose (*Psychol Rev.*)
'21	Nunn		Kuo Giving up Instincts (*J Phil*)
'22	Holley (1)	Dunlap *Elements of Scientific Psychology*	Contributions to endocrinology by Schafer, Marshal, and Stewart Stone s articles in *J Comp Psychol*, *J Exper Psychol*, etc
'23	Bolton	Thurstone	Kantor's articles in *Psychol Rev*, etc
'24	Averill	Child *Physiological Foundations* Watson *Psychology from the Standpoint of a Behaviorist* Herrick *Neurological Foundations*	Moss Obstruction Method (*J Exper Psychol*)
'25	Edwards Fox Saxby	Köhler *Mentality of Apes* Thomson *Instinct, Intelligence, and Character* *Psychologies of 1925*	Watson Powell Lecture, Clark University
'26			International Congress of Psychology
'27	Cameron (11) Sandiford Gast and Skinner	Adler *Individual Psychology*	
'28			Kuo's articles in *Psychol Rev*, *J Comp Psychol*
'29	McRae Pintner		
'30		*Psychologies of 1930*	
'31	Trow		
'32	Ogden and Freeman		
'33	Hollingworth		

posed here to confine attention to a "vertical," that is, chronological examination of the publications in the one area of educational psychology. From this point of view (though any strict stratification would be obviously impossible), the work of the forty years falls into four more or less clearly defined phases

The first phase covers the twenty years between 1893 and 1913. In the general field, it had been ushered in by James's work, while Lloyd Morgan during the first decade centered much interest in his comparative studies of animal behavior Towards the end of this period, McDougall's work appeared, at once reflecting and focussing British psychological thought along a purposive quasi-mentalist path In the interim, the Peckhams and Jennings had made their significant contributions in biology, the first work of Pavlov and Sherrington had been published, while the child studies of Hall had taxed the contributors to many questionnaires.

The texts in educational psychology at this time reflect, in regard to their treatment of instinct, some of the effects of this rapid accumulation of data One finds scattered references to the new discoveries—at times they are drawn upon for purposes of illustration—but one's tendency to read into many of these observations interesting foreshadowings of later developments receives a salutary check from the frequent lapses into the psychology of an earlier day. In any case, it is obvious that the question of instinct and problems of the dynamics of human behavior do not lie at the center of their thinking. Thus Judd, writing upon "Genetic Psychology," does not mention instinct or emotion by name. He points out that for many situations there are unconscious preparatory muscular responses, and he insists that the organic "activities accompanying impressions" constitute an essential part of the situation He mentions the changes in circulation and digestion which take place in certain situations, even referring to the X-ray observation of peristaltic movements in a cat, but he is not concerned with coordinating this collection of facts or with discussing the causes and relationships of feeling and action. He is much more interested in a detailed consideration of the moral issue as to whether a child is innately good or bad!

Bagley (1) in his *Educative Process*, makes one of the earliest references in the literature to the purposive significance of instinct He suggests that man has certain innate needs, correlated with the

fundamental instincts, such that, when one or other is predominant, relevant "objects of the external world appeal to one" (pp 83-84). This interesting anticipation of McDougall's definition is not developed in any systematic fashion The book is characteristic of the period in showing much greater interest in philosophical discussions of the implications of heredity, or in debating the very live question of the transmission of acquired characteristics On the other hand, when brought, in the course of argument, to a need for a more detailed examination of "instinct," the texts of this period, beyond suggesting that it is a "complex reflex," declare the topic to be one for comparative psychology. Even Lloyd Morgan, in his *Psychology for Teachers,* makes surprisingly little use of the data derived from his animal studies

Despite the indifference which postponed any resolute exploration of the instinct problem, the question of the mind-body relationship could not long be kept in the background Munsterberg (10), who does not attempt to discuss instinct or emotion, prefaces his *Psychology and the Teacher* with an enunciation of the principle of psychophysical parallelism as "the fundamental theory of modern psychological thought" This position makes it possible for him to propose that education implant certain feelings in the child mind.

> If feelings were really what popular psychology is inclined to make out of them, the task of their training and education and artificial molding would necessarily seem hopeless The teacher would be obliged to stand by and wait for natural growth . (p 203)

Pyle takes up the same parallelist position, but he seems to recognize that such a doctrine begs the essential question of the mind-body relationship for he suggests that a more rigid scrutiny of the problem is impossible in the absence of adequate data. At the same time, he declares that the immediate solution of the problem is not a pressing need for educational psychology.

British educational psychology is represented, at the close of this period, by Welton and Dumville Of these writers, Dumville is by far the more thorough-going exponent of the McDougall psychology Welton is far from dogmatic He suggests that the term instinct would be better applied to certain broad *classes* of reaction than to specific reactions He is loth to draw any dividing line in a series which varies from behavior due to complicated reflexes to behavior largely due to learning Dumville, on the other hand,

takes up a definitely mentalist position Significantly enough, he relegates any discussion of the mind-body relationship to the sphere of metaphysics. Thus he is free to speak of conation as "the mental force (correlated on the physical side with nervous energy) which sustains the course of all human activity" (3, p. 248). Dumville describes instinct as a process, but goes on to use it in his exposition as an entity, or rather, as a series of entities. He attaches to each instinct an emotion, but again does not propose to examine their precise mechanism or origin, but to pass on to a discussion of their educational implications.

A contrast of this type of approach with the work of Thorndike, which appeared in the following year, serves to throw into relief the characteristics of this period At first there had been little interest in the instinct problem, certainly no conception of it as of fundamental significance for the whole of educational psychology. The focus of attention was either centered upon the sociological implications of heredity—that set of factors which was called upon to explain so much—or upon a detailed examination of the various cognitive processes. Little need was felt for any explanation of instinct other than its description as a "complex reflex." At the same time, facts of everyday experience suggested the possibility of a more dynamic interpretation of life and resulted in a rather loose use of the terms "instinct," "emotion," and "feelings." The purposive psychology of McDougall was the first frank attempt to face this situation. The result was a rather over-systematized statement of a psychology which asserted the peculiarly mental character of much of human experience and substituted a "psychophysical disposition" for the "complex reflex" of the comparative psychologists. Wherever one looks, however, during this period, one is conscious of a singular dearth of experimental evidence or inquiry

The contribution of Thorndike to this problem may be regarded as a stage in itself Even after the accumulation of the data of another twenty years, and despite the attacks of his critics, that contribution has, in its fundamentals, remained virtually unchanged There are, however, more significant reasons for Thorndike's outstanding position in this discussion Thorndike's earlier contributions in this field have hitherto been ignored in this paper because, in reality, they constitute a preface to the larger work which began to appear in 1913. Together, they represent the first truly experimental approach to the problem.

While one feels that in regard to instinct Thorndike's exposition ultimately outstrips the modicum of experimental data he had at his command, it is obvious that he performed a signal service in seeking to define the ground of the debate and to clear it of much encumbering verbiage. In the process of this re-examination, Thorndike surveyed the various characteristics which have been accepted as criteria of instinct. It is refreshing, after two decades of definition by contrast, or from a teleological point of view, to be reminded that none of these criteria show specific causal relationships and that, while useful expressions of probability, they are no substitute for direct observation and experiment. Finally, Thorndike's resolute statement of the complex nature of all behavior, while not original, was most timely.

Out of this determination to limit his study to facts which are observable and verifiable spring both the strength and the chief causes for doubt in the Thorndike psychology of instinct. On the one hand, all talk of "instincts" as if they were entities, "magic potencies" dangerously approaching a new type of faculty, is immediately discredited, on the other, an explanation in terms of "even roughly definable bonds between actual situations and actual thoughts, feelings and actions" arouses a protest from those who would stress the part played by the organism itself in the total situation. The latter would contend that not only must the organism be taken into account as a central factor in the S-R relationship, but that there are inherent in the instinctive response certain characteristics which cannot be directly observed or immediately verified, and that these subjective elements constitute perhaps the most significant aspect of the situation.

It is impossible to attempt here any detailed statement of the introspectionists' quarrel with Thorndike's method of approach It is interesting, however, to note that he himself admits the incompleteness of his data and the tentative nature of his conclusions. Nevertheless, it seems that in the almost unscientific ardor with which the search for objectivity is pursued these preliminary acknowledgments are quickly forgotten. As soon as the strictly objective method is applied to the problem of "satisfiers and annoyers" and their relation to behavior, the matter is brought to a test At this point, as it seeks refuge in one definition after another, Thorndike's exposition becomes rather unconvincing Nor, indeed, is the position improved when he passes to a discussion of emotion. Here he seems to be

more concerned with emotion as a factor in the meaning content of a situation than as a dynamic of behavior. He does not link emotion up with his "satisfiers and annoyers," but passes on to a criticism of McDougall. Here, it is interesting to notice, the burden of his criticism is upon the unreliability of introspective data.

The purposive psychologists have insisted that Thorndike's relegation of emotion to a secondary rôle is even more open to criticism than McDougall's early conception of emotion as an invariable aspect of each specific instinct. They have also retorted that Thorndike's psychology gives him little basis for attacking such a problem as persistence of behavior despite immediate consequences, or for explaining circuitous endeavor whose ultimate satisfaction must be long delayed.

Whatever may be one's reaction to Thorndike's treatment of the problem, three facts seem clear at this stage: first, the problem of instinct has been brought to the fore in educational psychology; secondly, a definite attempt has been made to initiate a scientific attack upon the problem; and, thirdly, with the publication, in 1914, of Watson's *Behaviorism,* the discussion proceeds with increasing warmth.

The decade which follows is therefore, from the point of view of the textbook literature, a disappointing interregnum. Not only are the problems of instinct and emotion dealt with in many of the texts in rather inadequate fashion, but the thinking which lies behind them seems to have been completed in the previous decade. Even Starch's text devotes comparatively little space to these problems, indeed, that author declares that "in much of the writing and thinking concerning educational problems, there has been a relative overemphasis in space and time upon instincts" (15, p. 12). To this general rule, the texts of Nunn and Gates are outstanding exceptions.

Nunn's work, though it moves farther than most into the field of education, is an excellent discussion of many of the psychological aspects of the problem. While his is a "hormic" psychology, he is not uncritical of McDougall, but suggests that in his psychology the latter (together with Bergson) "seem to have surrendered to the mechanists as far as body is concerned, and seek to redress the situation by involving the mysterious aid of a 'deus in machina'" (11, p. 40). He further suggests, while discussing Drever's criti-

cism, that "there is a danger lest McDougall's scheme, too rigidly maintained, should land us back in a quasi-mechanistic theory, leading us to think of a man's self as built up of instincts much as a machine is built up of wheels" At the same time he asserts that McDougall's exposition is fundamentally sound in three of its features, namely, that emotions and kindred states are certainly the prime movers of human activity, that without doubt they are indissolubly connected with specific types of activity, that they remain the central core of the most complicated environmental product. At the end of this decade, the same point of view is set forth in lucid fashion in an Australian text by McRae (8).

Gates is the other important exception during this period in that he devotes a considerable portion of his text to a thoughtful consideration of some of the implications of current theories of instinct. He points out the lack of any sharp line of demarcation between reflex and instinctive action, but almost immediately suggests that the dynamic impulse which characterizes emotion is its real hallmark Upon further examination, his position seems to be of the "two aspect" type Each stimulus to instinctive behavior, he declares, activates a state of readiness; for example, the state of "hunger" is a preparatory reaction "consciously experienced as impulse" "The bodily state of readiness and the conscious impulses are typical of all complex instincts. They are directed towards some consummatory reaction or series of reactions" (5, pp 124, 133). Gates confesses he is loth to use the term "instinct" because of its current misuse. The ideal procedure, he says, would be to push one's analysis back to specific stimulus and specific response This, however, is impossible, so he consents to use the term. "It is important to remember, however, that each so-called instinct is not an independent, discrete invariable entity or power, but merely an aggregate of specific impulses and reactions to specific stimuli, with a ragged and changing boundary"

When he passes over to a discussion of emotion and the part which impulses may play in modifying conduct, Gates's thought becomes more difficult to follow He suggests that Thorndike's "satisfiers and annoyers" are the best available explanation of persistent behavior and that their basis is probably to be found in "some fundamental organic neural condition or change" He distinguishes between these dynamic forces and emotion. "Emotion, as a psychological term, refers to the state of consciousness, that is, to the

complex of sensations and not to the bodily activities themselves. . ." These groups of sensations are "diffuse, mixed, unanalyzable groups" and function only when the organic stimuli are intense Did space permit, a discussion of the educational implications of such a theory of emotion would be found to be full of challenges It may be noticed, in passing, that such a position affords no final answer to the question, if any dynamic significance be given to emotion, whence that force is derived.

Sandiford's 1927 text (14) may conveniently be taken as the earliest representative of the fourth phase of this discussion His treatment of the problem is of interest, first, as a good summary of the available data and as a statement of accepted opinion six years ago. In the second place, Sandiford prefaces his work with a sevenfold indictment of introspection as a method of psychological inquiry, and this is obviously not without significance for his later treatment of instinct and emotion. Yet in the latter discussion his reliance upon objective analysis seems to leave him somewhat dissatisfied. His conclusion in regard to instinct remains indeterminate, and when he turns to criticize McDougall's theory of emotion he is forced to admit the need for some dynamic in education After searching for such a basis for motivation he concludes that the topic is "one of the least known in the psychological field"

Indeed, if it is possible to arrive at any generalization in regard to the texts of recent years, they might be looked upon as reflecting the attempts of many workers to retain their objectivity of outlook and method while seeking more satisfactory solutions to insistent problems which remain stubbornly subjective. Gast and Skinner voice a "reluctant reaction" against much of contemporary behaviorism Pintner reviews the whole situation and in his dissatisfaction with all proposed theories would go so far as to say that "what we inherit is merely a vague unrest, a vague and indefinite tendency to respond. . . " (13, p 16) Similarly, the work of Monroe, DeVoss, and Reagan is professedly eclectic in its treatment of fundamental issues. Such an attitude is another product of dissatisfaction. These authors "agree with the behaviorists in part, but they also believe that the method of introspection may be employed and that it is necessary to give attention to conscious processes" (9, p 16)

The last three texts in the table above are not only the latest products of this period of reaction, but they serve to illustrate three

ways in which this revision of old ideas may express itself The text of Ogden and Freeman is a radical revision of Ogden's work in 1926. Such changes as have been made "are intended to clarify the point that psychology is an objective study of behavior" (12, pp. ix, 29, 58) Throughout their work these writers accept all the objective data offered by the biologist, the animal psychologist, and by the studies of Watson, but they interpret them all in terms of their "gestalt" psychology. Their mode of treatment, when applied to the problems of motivation, instinct, and emotion, leaves one with questions unanswered After discussing the various ways in which the organism may react to its environment, the authors observe "we must not suppose that these varied means account for motivation Both externally and internally conditioned responses are motivated by organic needs In either case we have as our central problem the concrete effort of the organism to restore its disturbed state of dynamic equilibrium" Indeed, the whole problem seems to remain uncovered in that phrase a "disturbed state of dynamic equilibrium." Similarly, the discussion of the various modes of predominantly instinctive behavior is "illustrative rather than comprehensive" on the grounds that "the factual data are too indefinite to permit a comprehensive treatment of the subject"

From the point of view of the present discussion, this work of Ogden and Freeman, drawing readily upon many types of data and couching its conclusions in rather cautious terms, reflects the vast amount of work which had been done in physiology, in psychology, and in allied fields since Thorndike's 1913 work. In short, this text represents a complete revolution from some of the dogmatic statements in texts of earlier years It further illustrates the inherent difficulty of resolving to treat these problems in a strictly objective fashion On returning to a discussion of affection and emotion at a later stage, the hypothesis is again advanced that behavior is the product of the organism's efforts to regain its equilibrium In seeking an *explanation* of motivation they turn "both to physiological and to psychological observations" Of the former, they quote Coghill's assertion from the point of view of a neurologist that the organism is intrinsically activated, their psychological discussion might well have come from introspectionists with its acceptance of curiosity, self-assertion, and the rest, both as behaviors and as "farces"

Trow's discussion of the problem (16, p. 504) is of greatest

interest because it frankly sets before the student at the outset some of the issues involved in the several methods of approach to psychological studies He is thereby able to cover this group of problems under the headings "Motivation," "Emotions," and "Adjustment." In regard to instinct, he outlines each of the proposed types of explanation together with a survey of the data which are presented and the implications which follow Then, without forcing the matter to a definite conclusion, Trow proceeds to point out the applications to education of many of the facts reviewed, even though a final answer to the more fundamental questions cannot be given.

Hollingworth's recent work (6) is a further example of a striving for objectivity of treatment while obviously dissatisfied with some of the results which that approach has already yielded. For this writer, too, the stimulus is primarily a disturber of an equilibrium of inner stresses and strains. Motivation becomes, in his treatment, not so much *a power as a member in a reaction sequence The explanation* of the real cause of the behavior seems to remain a mystery Hollingworth would abandon the term "instinct." Most of its interpretations are unsatisfactory, whether it be as a power or faculty, or as a "brain pattern," or as a non-material "disposition." It is refreshing to hear much of neurological hypotheses of psychological texts dubbed "pseudo scientific allegory" For all these Hollingworth would substitute "organic distress," but a careful examination of his exposition affords one nothing more than a good description; it cannot lay bare ultimate causes or bridge the gap, however narrow, between body and mind

A comparison of the last two texts raises the very significant question as to whether it is better to place all the facts of the various "schools" before comparatively immature students, or whether it is better, in a text in educational psychology, to explore at length the implications of one's own hypothesis.

Behind this discussion of the treatment of instinct and emotion lie certain fundamental issues which, though they may lie too deep for immediate and final answers, must be clearly envisaged by all those who would teach educational psychology or prepare texts for teachers' use. Most of these are the concern of all those who are engaged in psychological study, one at least is the peculiar concern of those working in the field of educational psychology Obviously, one's conception of the province and methods of psychology plays a significant part in determining one's attitude towards these problems

of instinct and emotion These twin problems are virtually test cases for most of one's psychological assumptions Texts in educational psychology might well make a specific attack upon this question of scope and methods, not at the outset, when students are completely lacking in orientation, but as a form of review of concepts which have been assumed, and as a preparatory step towards more advanced work

Throughout the history of this problem, in so far as it has been discussed in elementary texts, the tendency has been to thrust aside the second fundamental issue—that of the body-mind relationship. Yet some discussion of this problem is inherent in any study of instinct At least such a discussion should prevent one's treatment of instinct becoming that dogmatic and uncritical repetition of formulae which is the refuge of bewildered minds It is true that no final answer can be expected of a student class—or from their teacher—but at least that problem need not be consigned, on sight, to the realm of metaphysics.

The third foundation of any treatment of the problem of instinct is the recognition of the fact that it is not one problem, but many. Several subsidiary questions suggest themselves Are there specific "instincts" or types of instinctive behavior? What are the "differentia" of instinctive behavior? What is the relation of emotion to instinct? What are the sources of motivation? Is there any "will"? Why *do* people behave? The question of motivation is especially pertinent in this connection. For years educationists have echoed the word "motivation" and familiarity with the sound has tended to postpone further inquiry into its meaning

A fourth issue, while less profound, is none the less of great significance In how far do textbooks and lecture courses in educational psychology grow logically out of answers to the questions raised above? It is one of the dangers of the uncritical type of discussion of the problem of instinct that a real hiatus exists between teaching upon this topic and treatment of other topics in the course. Discussion of instinct theory without due regard for the implications of one's conclusions plays havoc with the logic of one's later exposition of the application of psychological principles to classroom practice And one's responsibility is the greater because, in education, no lives are lost and no buildings crumble spectacularly to betray faulty theory or bad technique.

More than one teacher of educational psychology has raised another issue Is a discussion of the problem of instinct a profitable one for textbooks in educational psychology? Has not the point been reached where any full comprehension of its implications is impossible without a knowledge of psychopathology, of neurology, of endocrinology, and a host of other fields of study? It is true, no doubt, that the psychologist who has had little clinical experience and perhaps no preparation for entering into the work now being pushed forward into the psychophysical borderland must be content to receive "dispatches from the front" somewhat at second-hand. But surely he is ill-prepared for his teaching task if he cannot at least understand the dispatches! But, more significantly, the teacher of educational psychology, in addition to expounding the psychological principles underlying teaching practice, must look upon himself as a provoker of thought. In regard to the problem under discussion, it is not enough that students should receive certain dogmatic statements of fact, it is much more important that they should be brought into contact with the very issues to which their teacher can give no final answer, that they should seek the implications of the problems rather than listen to final utterances about it

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LES CONTRIBUTIONS AU PROBLÈME DE L'INSTINCT DANS LES MANUELS DE PSYCHOLOGIE ÉDUCATIONELLE

(Résumé)

Dans les manuels de psychologie éducationnelle, surtout dans ceux edités pour l'emploi des classes, il y a un retard perceptible, non seulement quant à la recherche, mais aussi quant aux livres récents de psychologie pure Cela est clairement vrai à l'égard de la discussion de l'instinct et de ses problèmes associés

Ce fait semble se montrer dans le Tableau I Le tableau donne dans une colonne une liste des rapports de recherche, et dans une autre les oeuvres éditees qui font quelque contribution au problème de l'instinct Il rend possible ainsi une comparaison chronologique des manuels de psychologie éducationnelle.

L'examen de ces manuels montre quatre phases dans la discussion du problème Dans la première (1893-1913), on n'a vraiment pas appuyé sur la signifiance de l'instinct, bien que l'on ait su beaucoup de faits signifiants La psychologie éducationnelle a été surtout mentaliste Vers la fin de cette phase, cependant, les manuels anglais montrent l'influence de McDougall Deuxiémement, l'oeuvre de Thorndike est une partie d'un essai d'attaquer ce problème expérimentalement Cette approche a compris la déconsidération de la méthode introspective et a produit une confiance en S-R, la psychologie du "lien" La troisième phase, (1913-1927), a hérité cette psychologie, et, à deux exceptions, n'a pas fait de progrès comparables à ceux faits par la psychologie genérale et la biologie La quatrième phase, (1927-), semble montrer une réaction contre les insuffisances d'une approche purement objective, bien que les écrivains continuent à se mefier de l'ancienne terminologie mentaliste

On ne peut pas permettre à l'enseignement de cette matière, même pour les commençants, de devenir dogmatique, car la question entière doit rester ouverte pendant longtemps

WYNDHAM

BEITRAEGE ZUM PROBLEM DES INSTINKTES IN LEHRBUECHERN DER ERZIEHUNGSPSYCHOLOGIE

(Referat)

In Lehrbuchern der Erziehungspsychologie, besonders in denen, die zum Schulunterricht bestimmt sind, gibt es ein bemerkbares Zuruckbleiben nicht nur hinter der wissenschaftlichen Forschung, sondern auch hinter den neusten Abhandlungen der reinen Psychologie Dies ist besonders der Fall bei der Behandlung des "Instinkts" und seiner verbundenen Probleme

Diese Tatsache ist ersichtlich aus Tabelle I Die Tabelle gibt in einer Spalte Berichte uber Forschungen, und in einer anderen herausgegebene Werke, die zu dem Problem des Instinkts beitragen Dies ermoglicht einen zeitlichen Vergleich der Lehrbucher in Erziehungspsychologie

Eine Betrachtung dieser Lehrbucher zeigt vier Stadien in der Behandlung des Problems In dem ersten (1893-1913) hat man nicht viel Betonung auf die Bedeutung des Instinkts gelegt, obgleich viele bedeutenden Tatsachen bekannt waren Erziehungspsychologie war hauptsachlich geistig Gegen Schluss dieses Stadiums zeigen englische Lehrbucher den Einfluss McDougalls Zweitens ist Thorndikes Werk ein Teil eines Versuches dieses Problem experimentell anzugreifen Diese Methode erhob einen Zweifel an der Selbstbeobachtungsmethode und bewirkte ein Vertrauen zu dem Reizpsychologie Das dritte Stadium (1913-1927) behielt diese Psychologie und mit zwei Ausnahmen machte keinen Fortschritt, der vergleichbar mit dem in der allgemeinen Psychologie und Biologie ware, Das vierte Stadium (1927-) scheint eine Gegenwirkung gegen die Unzulanglichkeiten einer reinen objektiven Methode zu sein, obgleich die Fachleute Misstrauen gegen die fruhere mentalistische Terminologie hegten

Unterricht auf diesem Gebiet, sogar bei Anfangern, darf nicht dogmatisch werden, denn das ganze Problem muss auf langere Zeit offen bleiben

WYNDHAM

SHORT ARTICLES AND NOTES

THE LEARNING OF AN ELEVATED MAZE BY BLIND AND NORMAL RATS

WAYNE DENNIS

Within recent years Wever and Stone have shown very adequately that there are maze situations in which blind and normal rats make identical learning records (10) This is in agreement with the early experiments of Watson (9) However, these experiments should not be taken as proof of the general proposition that vision never has an influence upon the learning of a maze Mazes differ and studies other than those mentioned show that the loss of vision is a distinct handicap in the learning of some mazes (See 5, 6, 7)

It is perhaps not useless to report another investigation which shows that vision plays a part in the learning of some mazes, for by the accumulation of such data we may eventually arrive at some generalization as to when the sense of sight does and when it does not have a rôle in the maze habit The experiment here reported was carried out in the fall of 1930 I am indebted to Dr R H Henneman for assistance in the training of the rats

APPARATUS AND SUBJECTS

The maze was of block elevated construction and was the same one which was used in the study of initial maze behavior reported earlier (4) A diagram is given in the earlier article and is not duplicated here In brief, the pattern was a simple alternation or zigzag pattern of T-units It contained thirteen true sections and twelve culs-de-sac The apparatus was set up in the animal laboratory in quite heterogeneous surroundings

Ten normal and ten blind untrained rats of Wistar stock were used They were approximately three months of age, and equally divided as to sex

PROCEDURE

Prior to the first trial the animals were deprived of food in their cages and fed upon the food box of the maze (slightly detached from the maze in order to prevent exploration of the maze) for thirty minutes daily for two days Thereafter at the same hour all the animals were given one trial per day for nine days After nine days the procedure for all animals was not identical The blind animals, because their learning was incomplete, were continued in routine training through the twenty-fourth day Half of the normal rats were run through the fourteenth day, then blinded and given the usual trial per day for six days The remainder of

the normal rats on the days immediately following the ninth trial were submitted to certain tests for cues which are not reported in this paper.

Food was used an an incentive. No records of subjects' weights were made, but the animals appeared highly motivated at all times.

An error was recorded if the rat entered a cul with its forefeet, or to a greater extent. Retracing the true pathway is not counted as an error in this report, but entrances into blinds while retracing are included among the errors.

A time limit of twelve minutes was placed upon the first trial. One blind and four normal rats failed to reach the goal within this period. The errors which they made during this time constitute their error record for the first trial. No rats failed to reach the goal in later trials.

Results

Table 1 gives the number of errors per rat for each trial. Let us first examine the records of the rats for the first nine trials, during which time all rats were under identical conditions. During these trials the normal rats made an average of 11.7 errors, the blind rats an average of 22.8, or almost exactly twice as many. The greatest total of errors by a normal rat was 17. Only two blind rats had fewer errors than the most errorful normal rat. The $D/\sigma D$ of the total errors of the two groups for the first nine trials is 3.5.

Within the first nine trials the average number of errorless runs by normal rats was 5.2, by blind rats 2.6, or half as many. The $D/\sigma D$ of the two groups in this respect is 3.1.

All but one of the normal rats made three consecutive errorless trials within the first nine trials, only two of the blind rats did this.

Since the blind rats were continued in routine training beyond the ninth trial, it is interesting to compute the average number of trials required to meet a criterion of three consecutive errorless runs. However, in order to do this I have supposed that the "dullest" rat of each group would have met the criterion if given two more trials than were given the entire group. In each group training was discontinued when one rat had failed to meet the criterion, but the last trial of each of these rats was errorless. When the assumption described is made, the average trials before meeting the criterion are 4.3 and 14.8 for the normal and blind animals respectively, and $D/\sigma D$ is 6.5.

These comparisons demonstrate clearly the inferiority of the blind animals. Further analysis shows that the relative difficulty of the various maze alleys was almost identical for the two groups. The per cent of total errors in each alley from entrance to goal for the first nine trials was 36, 18, 16, 3, 4, 0, 5, 3, 4, 0, 3, 8 for the normal rats and 30, 15, 12, 4, 6, 3, 4, 3, 4, 6, 4, 9 for the blind rats. These figures are not significantly dif-

Normal Rats																								
1	10	1	0	0	0	0	0	0	0															
2	5	4	0	1	0	0	0	0	0															
3	6	9	2	0	0	0	0	0	0															
4	4	1	0	1	0	1	0	2	0															
5	3	6	1	1	2	1	0	0	0															
6	2	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
7	9	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0				
8	7	2	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0				
9	5	5	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0				
10	0	6	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0				
Total	51	45	8	6	3	2	0	2	0	0	0	0	0	1	4	0	0	1	0	0				
Blind Rats																								
1	5	5	1	1	0	3	1	4	4	2	2	0	2	1	1	4	1	0	1	0	1	0	0	0
2	11	10	1	1	0	0	2	4	2	2	0	0	2	0	0	1	0	1	0	0	0	0	0	0
3	6	12	2	2	2	4	0	1	0	0	0	2	0	0	2	1	1	0	0	0	1	0	0	0
4	6	17	1	1	0	0	0	0	0	0	1	3	0	5	2	1	1	1	0	0	0	0	0	0
5	8	2	1	1	0	1	1	0	0	1	0	0	0	0	8	2	0	0	0	0	0	0	0	0
6	1	1	1	1	0	0	1	1	0	1	1	1	0	0	2	1	0	0	4	2	0	0	0	0
7	8	5	2	1	0	1	1	0	1	1	1	0	2	1	0	0	1	1	0	0	0	0	0	0
8	16	3	1	0	2	0	1	2	2	1	1	2	0	2	0	0	0	0	0	0	0	0	0	0
9	21	4	3	2	3	10	1	0	0	1	7	1	0	0	0	1	1	0	0	0	0	0	0	0
10	12	0	1	0	1	0	0	1	2	2	0	2	0	2	1	1	1	0	3	0	1	1	1	0
Total	95	59	14	10	8	19	8	13	11	11	13	11	6	11	16	12	6	3	8	2	3	1	1	0

ferent Each shows a progressive decrease of difficulty within the first four alleys

As stated earlier five of the normal rats were blinded after trial 14 and given six further trials at the rate of one per day Their record is shown also in Table 1 In the six post-operative trials which were given each animal, one rat made no errors, three made one error each and one made two errors In other words, although vision seemed to have aided learning, the loss of vision only slightly if at all affected the finished habit

I have previously shown that normal rats when placed upon a maze of this sort for the first time make many fewer errors than would result from chance behavior (4). It remains to be observed that blind rats also make fewer than chance errors. In first passing each bifurcation of the present maze in a forward direction (120 choices) the blind rats chose the blind alleys in only 39 per cent of the cases The comparable figure for normal rats in the previous study was 31 per cent.

One blind animal went from entrance to exit upon the first trial with only one error. Remembering that there are possibilities of error when the animal is proceeding from any one of twelve sections of true pathway, one sees that the probability of such accuracy by chance alone is very remote The one error was in the first blind alley In the first six trials the rat never entered any other blind than Blind 1. This picture of individual maze behavior is presented as a contrast to the usual portrayal of "typical" maze behavior, with its excess movements, exploration, and trial and error Most theories of maze learning are theories of "average maze learning" and do not adequately take into account the individual differences which rats present

In an earlier paper I called attention to the fact that in maze learning some culs are never entered (4). This is again demonstrated in the present experiment Within the first nine trials, not a single normal rat entered Blinds 6 and 10. Individual rats, of course, avoided many other alleys as well. No cul was avoided by all of the blind rats throughout the first nine trials, but each blind subject avoided one or more blinds throughout the entire twenty-four trials In accordance with the regressive order of difficulty, the alleys which most often failed to be entered throughout the entire course of an animal's training were the later alleys

Summary

Ten normal and ten blind rats were trained on a block elevated maze By several criteria the maze was found to be two or more times as difficult for the blind as for the normal animals and these differences were reliable Nevertheless five of the animals which were normal throughout the learning period were only very slightly affected by subsequent enucleation of the eyes.

Normal and blind animals alike showed the phenomenon of regressive order of difficulty of culs-de-sac The relative difficulty of the various culs was almost identical for the two groups

In addition to the comparison of sensory conditions, the study shows that high initial accuracy in this maze is possible in blind animals and that both blind and normal animals learn the maze without ever having entered one or more of the blinds

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AN INSTANCE OF *UMWEG* BEHAVIOR IN THE RAT

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In the course of an experiment on social behavior in the rat, the writers trained a group of rats to climb over a barrier to food This barrier was in the form of a square 18" on a side and 12" in height, located in the center of an open field, 48" square While no difficulty was experienced in training the rats to climb over the barrier, several of them evidenced some timidity, for the first few days, about eating in the large open area. These rats were observed taking food from the tin and returning across the barrier to eat in the smaller enclosed space On one occasion the experimenters were absent from the apparatus for a few minutes When they returned the food tin was found inside the barrier

On the following day, observation disclosed the following incident A female rat, upon being placed inside the inclosure, jumped immediately to the top of the barrier, surveyed the open field, jumped down and went directly to the food tin The tin was seized firmly in the teeth and pulled about 17" to a point 1" from the barrier The rat then jumped to the top of the barrier, balanced for about 10 seconds on the ¾ inch ledge, slowly leaned forward and down, grasped the tin again with her teeth, pulled the tin to the top of the barrier and dropped it on the inside. The total weight of tin and food was approximately 150 grams

This behavior was repeated for several days and an objective record in the form of moving pictures and stills was obtained In Figure 1 are presented six stills showing the critical points in the behavior sequence Figure 1*a* shows the rat surveying the field It will be observed that the food tin is at the edge of the open area Figures 1*b* and 1*c* show the rat seizing the tin and dragging it to the barrier In Figure 1*d* the rat is shown jumping to the top of the barrier The food tin is at the foot of the barrier and is not in the visual field of the rat Figures 1*e* and 1*f* show the rat reaching for the food tin and pulling it over the barrier

It should be pointed out that the rat was from the colony maintained by the Department of Psychology of the University of California, and that it had never before been placed in a situation which would allow opportunity for behavior of this sort

This, we suggest, is an example of the use of a round-about method to achieve a goal (in this instance, the goal is food-inside-barrier), similar to the problem solutions described by Kohler as "*Umweg*" During the act of jumping to the top of the barrier the food tin was temporarily out of the visual field of the rat, yet the sequence of acts had the coherence characteristic of a purposive behavior unit

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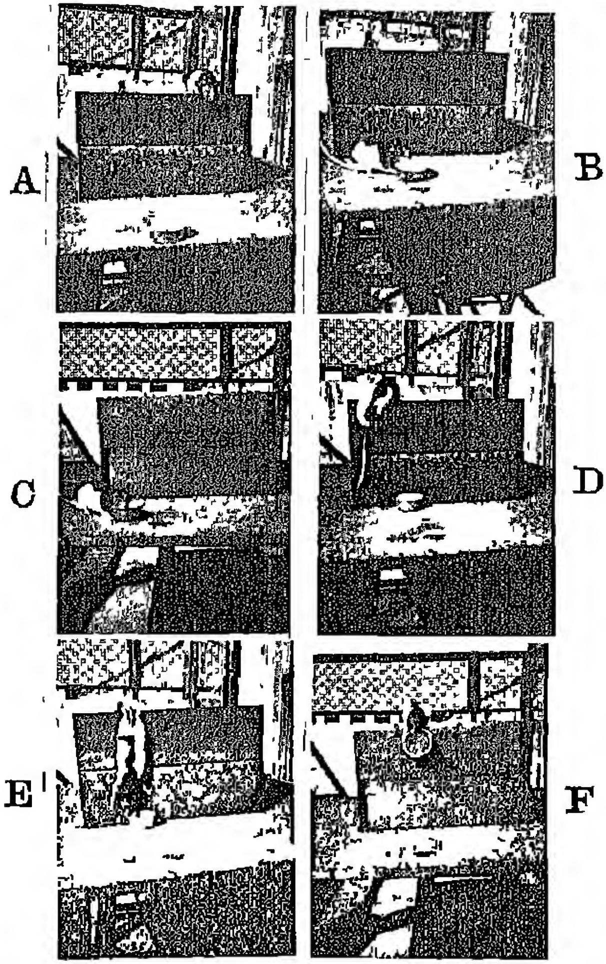

FIGURE 1

ELECTRIC SHOCK WITH DIFFERENT SIZE ELECTRODES

T A JACKSON AND B. F RIESS

The investigation here reported owes its inception to the increasing interest in the problems centering around the use of electric shock in psychological experimentation with human and animal subjects At a round-table discussion of the subject, led by Dr G R Wendt, during the 1933 Meeting of the American Psychological Association, one of the questions raised concerned the validity of the ordinary grill type of electrodes The writers have had some difficulty in using a grill with monkeys, for it appears the animal is shocked only as it first touches the grill, that is, while the area of contact is very small Once the animal has taken a step onto the grill, the skin area in contact with the electrode is much increased, and, it appears, the amount of shock the animal gets is much decreased The phenomenon is doubtlessly related to the principle of surface density This paper represents a preliminary study of the relation between the area of the skin in contact with the electrode and the amount of electric current required to produce a given subjective shock (lower limen for pain shock) Three adult male human subjects were used in the experiment and the area stimulated was the ventral surface of the first segment of the left middle finger

The apparatus consists of three units, an interval timer,[1] a stimulator,[1] and the assembly of electrodes of varying areas The duration of the stimulus was controlled by the interval timer (Likert Chronoscale) and was ½ second throughout the study A stimulator[2] designed by Dr T N Jenkins was employed to control the amount of current applied in a given stimulus presentation This apparatus consists essentially of a step-up transformer (input 110 volts, 60 cycle, A C), a voltage divider, and a battery of precision resistors The main principle embodied in the design of this instrument is the use of high voltages (usually between 500 and 1000 in the present study) and large external resistance (1 to 16 megohms) in series with the subject By varying the voltage and the external resistance at the same time a wide range of currents can be obtained In this connection it should be noted that by current is meant the calculated current based on the voltage and the external resistance, that is, the amount of current that goes across the electrodes when they are short circuited rather than the amount the subject gets when he is stimulated The range of currents used was from 0 01 to 0 70 milliamperes The electrode assembly (Figure 1) consists of a piece of fiber board in which eight pairs

[1]The writers are indebted to Professor C J Warden of the Department of Psychology of Columbia University, for permission to use these pieces of apparatus

[2]For a description see Warden, Jenkins and Warner (1)

of electrodes are set, one of each pair, the "indifferent" one, being of constant size (9.0 mm in diameter). The diameters of the variable electrodes are as follows: 0.1 mm, 0.2 mm, 0.5 mm, 1.0 mm, 2.0 mm, 3.0 mm, 5.0 mm and 7.0 mm. All electrodes were of brass and set so that the ends were flush with the surface of the board. Small stalls were built around each pair of electrodes so that, upon various presentations of the stimulus, the same points on the surface of the skin would be stimulated.

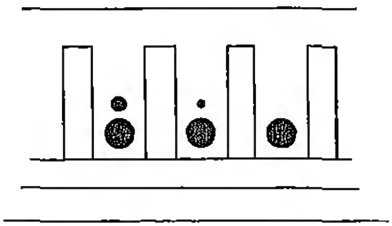

FIGURE 1
SHOWING A SECTION OF THE ASSEMBLY OF ELECTRODES

The general procedure used in presentation of the stimuli was a form of the method of "Constant Stimuli." The range of effective stimuli was first roughly determined for each electrode size. That is, the smallest current that would arouse a sensation, even a part of the time, was found, as well as the smallest current that would consistently elicit a definitely painful shock sensation. With these determinations a series of seven stimuli arranged in steps of equal current differences was chosen for each pair of electrodes. For example, the range for one subject for the smallest size electrode was 0.01 to 0.13 millamperes, and the seven stimuli chosen were, 0.01, 0.03, 0.05, 0.07, 0.09, 0.11, and 0.13; similarly for the largest size the stimuli were 0.10, 0.17, 0.24, 0.31, 0.38, 0.45, and 0.52 milliamperes. Since the interval timer made a certain amount of noise when the stimuli were presented it was decided to give a blank presentation along with each series of seven stimuli. This was done to prevent the possibility of the subject's responding to secondary cues. Immediately before a stimulus was presented the subject placed his finger on a pair of electrodes and maintained a reasonable degree of pressure until stimulation ceased. The time between successive stimulus presentations was about 20 seconds. During this interval the subject removed his finger and held a handkerchief loosely in his hand; this was a means of maintaining a fairly uniform degree of dryness on the surface of the stimulated area. In order to insure that moisture from the skin would not accumulate on the fibre board and thus tend to form a short circuit, successive presentations were not given on the

same electrode pair. Ten series of eight stimulus presentations were given on each size of electrode. In the case of one subject all eight electrode sizes were studied; in the other two subjects only four were investigated, but it will be seen that the results from the latter fully corroborate those from the first subject. In obtaining judgments of the intensity of the sensations or shocks it was more or less arbitrarily decided to use five categories which are as follows: 0 = no sensation, 1 = very slight sensation of a "tactual" nature, 2 = vivid sensation of a "tactual" nature but not at all painful, 3 = a sensation in which distinct but very mild pain elements are present; 4 = a vivid pain sensation.

In order to compile the data it is necessary first to define, in terms of the judgments used, the lower limen for pain shock. Since a No. 2 judgment is never painful, according to definition, and a No. 3 judgment is always painful, then 2.5 should represent a point where pain elements are present just 50% of the time. A limen may be defined, according to the method of Fullerton and Cattell, as the point midway between 50% and the 100% points, which in this case would be represented by the value 2.75. By a process of interpolation the lower limen for pain shock, so defined (2.75), was computed for each electrode size for each of the three subjects. Table 1 shows these limens expressed in terms of current (milliamperes). Figure 2 shows the same data in graphic form. The obvious conclusion is that the larger the size of the electrode the greater the amount of current required to elicit a given shock sensation. It necessarily follows that the same relationship exists between amount of current and the area of skin stimulated, since the latter corresponded very closely with the size of the electrode. This conclusion holds at least for the conditions under which this experiment was conducted. The results, however, are not surprising for they are consistent with what was expected by the principle of surface density.

TABLE 1

SHOWING THE RELATION BETWEEN SIZE OF ELECTRODE AND THE AMOUNT OF CURRENT THAT WILL AROUSE A PAIN SHOCK SENSATION, LOWER LIMEN (2.75)

Diameter of electrode	Area of electrode	Limens expressed in milliamperes Subject 1	Subject 2	Subject 3
0.1 mm	0.008 sq. mm	0.057	0.088	0.102
0.2 mm	0.031 sq. mm	0.083		
0.5 mm	0.196 sq. mm	0.097	0.146	0.145
1.0 mm	0.785 sq. mm	0.135		
2.0 mm	3.142 sq. mm	0.173	0.285	0.222
3.0 mm	7.050 sq. mm	0.203		
5.0 mm	19.620 sq. mm	0.296	0.425	0.383
7.0 mm	38.400 sq. mm	0.355		

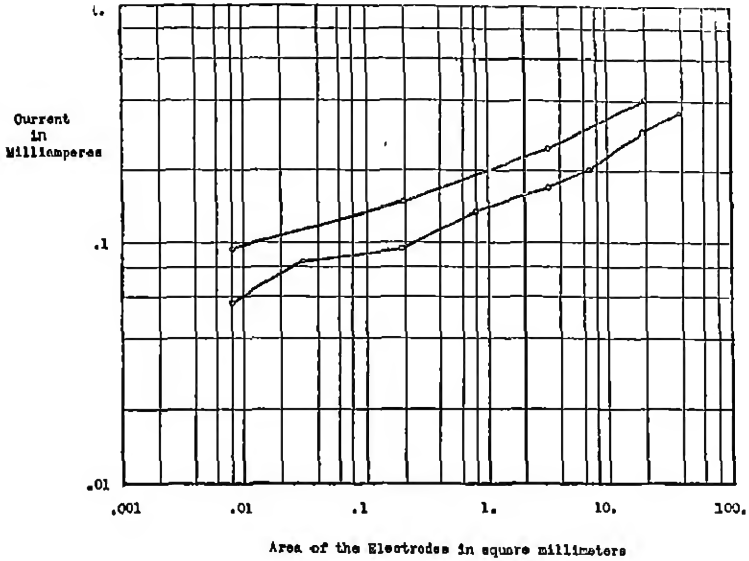

FIGURE 2

Upper Curve for Subjects 1 and 2 Combined, Lower Curve for Subject 1

If these results are valid, it would seem that in any sort of experimental work in which it is desired to administer a uniform electric shock, uniform from one stimulation to another and (or) uniform during a period of stimulation, great care must be taken to insure uniform area of contact between the electrodes and the skin of the subject If this is not done, and providing the current source is uniform, the resulting shock sensation will vary inversely with the area of contact When a large electrode (at least 20 to 30 square mm.) is used and the subject makes only a small fractional contact the shock sensation will be many times as intense as when full contact is made A current of appropriate intensity for full contact with a reasonably large electrode will not be appropriate for partial contact and vice versa As was mentioned earlier this difficulty is encountered in many experiments with animals where the subject is required to walk onto a grill. In these cases a current that will just shock the animal (cause it to squeal and run off) while standing on the grill, may, if minimal contact be made, produce so severe a shock as to "condition" the subject against the whole apparatus One solution of the difficulty is to construct a grill with very small electrodes, so that minimal and maximal contact approximate one another If this is done the animal can scarcely

increase the area of contact in the act of setting its foot on the grill, for any contact is practically full contact Of course if the animal's foot makes contact with several adjacent point electrodes the total area of contact will be increased and the shock proportionately reduced This additional difficulty may be avoided by the use of several independent current sources, so that there will be no two pairs of electrodes from the same source on the same foot area. Although the present study offers no evidence as to the optimum size of electrodes for grills, still it is clear that they should be very small, perhaps less than 0 5 mm in diameter

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A METHOD OF RATING SOCIABILITY IN YOUNG CHILDREN

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Observations, each thirty minutes in duration, were made of the preschool children in a Nursery Group, during free play periods either in the playroom or out of doors in the yard An observation card was drawn up as follows

W *watching, not actively participating.*
  1 appears vacant, daydreams?, sucks thumb
  2 watches activities of others with interest (but remains outside the group)
  3 participates passively, as a sympathetic observer
P *passive social contacts (not self-initiated)*
  1 refuses to respond to the advances of others (showing refusal aggressively)
  2 fails to respond to the advances of others (showing timidity)
  3. responds submissively to the advances of others
  4 responds co-operatively to the advances of others
A. *active social contacts (self-initiated)*
  1 contacts agressively with others.
  2 contacts timidly with others

*An abbreviated report of a study made under the direction of Ruth W Washburn, at the Clinic of Child Development, Institute of Human Relations, Yale University

3. contacts spontaneously with others
4. bids for attention
5. demands help
6. contacts co-operatively and eagerly

M *activities involving the use of materials only.*

Activities were said to terminate when another piece of apparatus was added to, or substituted for, what was already in use, or when the child's interest was transferred from one individual to another

A plus mark was made on the observation card under the appropriate heading, and the time noted in seconds whenever the observed child made a contact, or engaged in activity with materials. A verbatim report of language used by the child was also kept (Audibility was lessened when the child was out of doors) Afterwards this was classified under social vocalization and non-social vocalization, according as the child addressed himself or others

The time was kept with a stop watch The watch was stopped whenever the child went out of sight, and started again whenever he came into sight The observer was behind a one-way-vision screen when the child was indoors, and behind screen doors when the child was out of doors

Evaluation An attempt was made to obtain a qualitative measure of each child's social adjustment The following method was employed

1 The classified contacts were valued on a scale graduated according to their degree of overt sociability Active social contacts (A) are rated higher than passive social contacts (P), and this higher than watching (W) Within these categories the contacts were rated in ascending order of sociability. The combination of these principles lead to the following scale of marks or values which appeared to be sufficiently well based to establish a relative order of sociability and to study the consistency of behavior of a given child in different periods.

TABLE 1

W Watching		P Passive social contacts		A Active social contacts	
Item	Value	Item	Value	Item	Value
1	1	1	2	1	3
2	2	2	4	2	5
3	3	3	6	3	7
		4	8	4	9
				5	11
				6	13

In order to determine the ranking of each child on this scale of social adjustment, the observation cards were studied and the number of seconds the child maintained each contact (Tc), and the number of seconds spent in purely material activity (M) were computed The total time spent in each

TABLE 2

Name S S	W			Contacts P				Time in seconds A						Observation II Non-Contacts (M) Time in seconds
Items	1	2	3	1	2	3	4	1	2	3	4	5	6	
Values	1	2	3	2	4	6	8	3	5	7	9	11	13	
		10	10			51	7		39	37	25	5	68	29
		75	17				38		19	38		125	35	59
		59					50			24	35	15	50	20
		34									35		40	20
		31									6			32
		22									38			15
		30									22			31
											34			50
											46			46
											39			30
											55			50
											25			50
														60
														9
		261	27			51	95		58	99	360	145	193	
														511

Tc	x	Vc	
261	x	2—	522
27	x	3—	81
51	x	6—	306
95	x	8—	760
58	x	5—	290
99	x	7—	693
360	x	9—	3240
145	x	11—	1595
193	x	13—	2509
1289	x		9996
M 511	x	0	
1800			

1 Social Index $\dfrac{\text{Sum (time of contacts x values)}}{\text{Time of observation period}}$

$$\frac{S(Tc \times Vc)}{T} \quad \frac{9996}{1800} \quad 5\ 55$$

2 Score in Contact $\dfrac{\textit{Sum (length of contact x values)}}{\text{Sum (time in contact)}}$

$$\frac{S(Tc \times Vc)}{S(Tc)} \quad \frac{9996}{1289} \quad 7\ 75$$

3 Social Vocalization 28
(i e the number of times S.S vocalized in a social manner)

classified contact was then multiplied by the value given to that contact, according to the above scale for each of the three observations These products were then added Thus a child making numerous contacts for a considerable length of time under A6, for instance, would gain a much higher score than a child spending most of his time in random watching "W," or playing alone with materials "M" M scores 0, having no sociability value Not only the *number* of different contacts was considered, but also the *length* of contacts

2. In order to weight the score of those children who spent a greater percentage of their time in social activity than in material activity, the total sum of the products of times and values of each contact was divided by the number of seconds in each observation period, viz., 1800, and this was termed the Social Index.

$$S\,I = \frac{S(Tc \times Vc)}{1800}$$

3 In order to determine the average type of social activity the total sum of times and values of each contact was divided by the total number of seconds that the child spent in social activity and this was termed the Score in Contact

$$Sc = \frac{S(Tc \times Vc)}{S(Tc)}$$

4 Finally the number of times each child vocalized in each of the three observation periods in a social manner, i e, to others and not to himself, was determined, and this was termed the Social Vocalization, or Vs

Thus, three measures of sociability were obtained, the Social Index, the Score in Contact, and the Social Vocalization The following example will make this method of evaluating clear (Table 2)

These three measures were determined for each child in each observation period, and the mean computed

By this means a scale of sociability may be established The subjects may be ranked according to their scores, and a score both for the time they are in social contact, and a score over the whole time of observation whether in contact or not can be obtained

It is contended that the combination of qualitative and quantitative methods is of value

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THE DELAYED RESPONSE OF A CHIMPANZEE TO COLOR AS THE CONSTANT VISUAL FACTOR IN A VARYING SITUATION

FRED S KELLER

In an article, "Concerning Memory in the Chimpanzee," which appeared in the *Journal of Comparative Psychology* for June, 1928, Professor Robert M. Yerkes and David N Yerkes report two experiments dealing with delayed reaction in chimpanzees (6) The first of these concerns "delayed response to a complex unmodified situation" and the second deals with "delayed response to the constant visual factor color in a varying situation" Since the conclusions drawn from both experiments have been rather generally accepted (1, 3, 4, 5), critical comment would still appear to be appropriate It will be the purpose of this note to offer an analysis of the second of these two experiments and to question Professor Yerkes' position with respect thereto Reference to the first experiment will be made only when essential for the clarification of points in the second

The subjects of Professor Yerkes' investigations were four chimpanzees (Wendy, Dwina, Billy and Pan) The experiments were conducted in the haymow of a barn in Franklin, N H In the first study all four animals were used, in the second, only one, for reasons to be given later

In the tests on "delayed response to a complex unmodified situation" Professor Yerkes demonstrated the ability of the four animals to make a delayed reaction "apparently on the basis of position of the reward," when four possibilities of choice were offered (one of four boxes situated in the four corners of the experiment room and equidistant from the mooring-post or point of release in the center of the room) These delays were as long as three hours and involved no maintenance of bodily orientation during the delay period Apparently all of the criteria, as postulated by Professor Hunter (2) for the delayed-reaction experiment, were present

In this first experiment white, red, green, and black boxes were baited in irregular order, with equal frequency, and the same one never used twice in succession, delays were instituted, and then the chimpanzees were permitted to choose "If the food-containing box was initially chosen, the subject was allowed to take its reward and, returning to P (mooring post), to devour it at its leisure. If instead the choice was incorrect, the animal, unless otherwise stated, was drawn back to P and either given opportunity for another choice or returned to the living quarters"

The question asked in the second experiment was: "Can the chimpanzee correctly respond after long delay when a single factor of the total situation remains constant? Or, otherwise expressed, may recognition of a specific factor be substituted for response to a complex assemblage of factors, including both absolute and relative position?"

The specific factor chosen was color, and the problem was first attacked

by using one box (the white), baiting it in one position, removing the animal from the room, changing the location of the box in the animal's absence, bringing the animal back and permitting him to make his choice

In trial number two, the only one reported in which such conditions prevailed, two animals, Billy and Pan, went immediately to the *positions* which had been occupied by the box when baited, Wendy made a correct response, but would not eat the food thus uncovered, while Dwina alone got her food at the correct (and only) box, and ate it "These responses," says Professor Yerkes, "make it entirely evident that reaction to the correct box, after its location has been changed, is not perfectly simple and a matter of course"

Two weeks were spent in trying to discover a satisfactory method of procedure During this time Wendy grew sulky and was abandoned, Pan's responses were impulsive and blind, and Dwina was given up as a subject after sixty trials "because, in the more complex situation involving two or more boxes which were shifted after the process of baiting, she displayed little ability to respond to the isolated factor of color" Billy alone showed "evidences of observation and interest in the experimental situation" and, to the experimenter, it "was clear that he was trying hard to discover a basis for successful response"

Variations of technique were employed, after sixty-one trials, when the number of subjects had been reduced to one, Billy, until, after the one hundred and fiftieth trial, the following was adopted as definite procedure and used throughout the remaining period of observation "All four boxes were used, but for baiting they were placed in the secondary positions w, x, y, z, and after the animal had been removed from the experiment room they were shifted to the positions 1, 2, 3, 4 in such wise that the absolute position of the baited box was eliminated as basis of choice, and the relative positions of the four boxes usually were changed. In a given trial any one of the four colors might indicate the correct box" The four secondary positions were approximately in the middle of each side of the room, the positions 1, 2, 3 and 4 were in the corners The succession of positions around the room—in a counter-clockwise direction—was 1, w, 2, x, 3, y, 4, z

"In Table 2 we have tabulated as exhibits the essential conditions and results of trials 151 to 180 as given to Billy between September 1 and 4 In the third column the position of each box during the process of baiting is represented by appropriate letters Thus, in trial 151, Ww indicates that the white box was in position w Bx similarly indicates that the black box was at position x, and so on The fourth column, 'position for choice,' indicates the position to which the boxes were shifted in the absence of the animal, and therefore the situation to which it finally was required to react W2 means that white was in position 2, B3, that black

was in position 3, and so on The column 'correct box,' designates the color and position of the food-containing box Delay is indicated in the sixth column in minutes. The last column presents the response of the animal: the symbol + indicates correct choice, whereas a letter followed by a number, as for example B3 in trial 151, indicates instead that the animal incorrectly chose the black box in position 3

"Throughout this series of experiments a single opportunity for choice was given in each trial. If the choice was incorrect, the animal failed to obtain the reward, and was returned to the living quarters to await another trial"

A reproduction of Professor Yerkes' Table 2 is given herewith

TABLE 2 (from Yerkes)
DELAYED RESPONSE TO COLOR AS ONLY CONSTANT IN SITUATION

Date	Number of Trial	Position baited	Position for choice	Correct box	Delay	Response
September 1	151	Ww Bx Gy Rz	W2 B3 G4 R1	W2	10	B3
September 1	152	Ww Bx Gy Rz	W1 B2 G3 R4	W1	10	G3
September 1	153	Ww Bx Gy Rz	W2 B3 G4 R1	W2	10	B3
September 1	154	Ww Bx Gy Rz	W1 B2 G3 R4	W1	10	B2
September 1	155	Ww Bx Gy Rz	W2 B3 G4 R1	W2	10	B3
September 1	156	Ww Bx Gy Rz	W1 B2 G3 R4	W1	10	+
September 2	157	Ww Bx Gy Rz	W3 B4 G1 R2	W3	5	+
September 2	158	Ww Bx Gy Rz	G4 R1 W2 B3	G4	5	+
September 2	159	Ww Bx Gy Rz	R1 W2 B3 G4	R1	5	W2
September 2	160	Ww Bx Gy Rz	R1 W2 B3 G4	R1	5	+
September 2	161	Ww Bx Gy Rz	G1 R2 W3 B4	G1	5	B4
September 2	162	Ww Bx Gy Rz	G3 W2 R1 B4	G3	5	+
September 2	163	Ww Bx Gy Rz	B1 W2 R3 G4	B1	5	W2
September 2	164	Ww Bx Gy Rz	B4 W2 R3 G1	B4	5	G1
September 2	165	Ww Bx Gy Rz	B1 W2 R3 G4	B1	5	W2
September 2	166	Bz Ww Rx Gy	B4 W3 R2 G1	B4	5	G1
September 3	167	Ww Gx Ry Bz	R1 W2 G3 B4	R1	5	+
September 3	168	Ww Gx Ry Bz	W2 G3 R4 B1	W2	5	+
September 3	169	Ww Gx Ry Bz	G3 R4 B1 W2	G3	5	W2
September 3	170	Ww Gx Ry Bz	G4 B1 R2 W3	G4	5	+
September 3	171	Ww Gx By Rz	B4 R1 W2 G3	B4	5	G3
September 3	172	Ww Gx By Rz	B1 R2 W3 G4	B1	5	W3
September 3	173	Ww Gx By Rz	B4 R1 W2 G3	B4	5	W2
September 3	174	Ww Gx By Rz	B1 R2 W3 G4	B1	5	W3
September 3	175	Ww Gx By Rz	B4 R1 W2 G3	B4	5	R1
September 3	176	Ww Gx By Rz	B1 R2 W3 G4	B1	5	G4
September 3	177	Ww Gx By Rz	B4 R1 W2 G3	B4	5	W2
September 3	178	Ww Gx By Rz	B1 R2 W3 G4	B1	5	G4
September 3	179	Ww Gx By Rz	B4 R1 W2 G3	B4	5	+
September 4	180	Ww Gx By Rz	G1 W2 R3 B4	G1	10	B4

A glance at this table, wherein appears but nine correct responses out of thirty choices, suggests that Billy was unable to make a delayed response to the color factor. However, the experimenter asks us to consider a certain peculiarity of the animal's behavior.

After complete failure in the first five trials, and four out of five correct responses between 156 and 160, the "peculiar phenomenon appeared of rejection of a given box." Black, although presented thirteen times as the food-containing box, including nine times in succession, was only once chosen. Red also, according to the experimenter, was rejected, although in the entire data given we find but one such rejection, whereas we do find that green was rejected (i.e., not reacted to correctly) three times, and white was rejected six times, including five in succession. It is regrettable that we are not given complete data on trials 181-200 which appear to have played a very important part in determining the experimenter's conclusions.

This neglect of the black box is interesting and one is moved to speculate as to the reasons for such non-reaction to a color; but it comes as a surprise when Professor Yerkes tells us that in tabulating to determine the proportions of correct and incorrect responses it seems desirable to eliminate this series of perseverational mistakes. That is, for the forty trials between 161 and 200, we are asked to omit thirteen (twelve?) incorrect choices.

In the critic's opinion such an omission finds its only justification in the assumption that the chimpanzee is rejecting a single *color*. That the animal is rejecting no *position* in these trials becomes clear in glancing down the column of Responses. In trials 163-166 we find the position-choice of responses to be 2-1-2-1 (after which, incidentally, the animal responded correctly on the next day, 1-2, when the colors red and white were used), in trials 171-179 we find the following distribution 3-3-2-3-1-4-2-4 4. Of the thirteen choices in question, position 1 is chosen three times, 2 is chosen four times, 3 is chosen three times and 4 is chosen three times.

With the elimination of such data we find that the chimpanzee has made thirteen correct responses and fourteen incorrect ones in trials 161-200. Professor Yerkes then asks us to make further allowance for the marked influence of the previously correct box upon each choice, whereupon it should be clear that the "percentage of correct choices would run well over 50, whereas except on the basis of selection by color or some unintended cue or cues, it should not exceed 25."

The experimenter seems to refer here to the marked influence of the previously chosen *color*. Examination of the tabulated record shows that three incorrect choices in all might be attributed to the effect of the previously chosen correct color, two of which might equally well be regarded as perseverational tendencies with respect to position. Obviously, the sig-

nificance of this supplementary argument is not great Furthermore, if we consider this perseverational effect without reference to the *correctness* of *the immediately preceding choice*, we find eight choices of color and *seven* of position like those of the preceding trials Two of these involve similarity in position and color

That Professor Yerkes was not unexpectant of adverse criticism seems clear from his own remarks concerning the inadequacy of the tabulated results, and the subsequent emphasis placed upon descriptive reports of six "typical" trials.

In attempting an analysis of this descriptive matter it may be noted that for trials 185, 190, and 198 we are given no record of the immediately preceding choices, and that for trials 187, 191, and 198 we have no data on the immediately succeeding choices The descriptions offered instead have value, especially when coming from such a trained observer as Professor Yerkes, and were it not for the table given in the earlier part of his paper, as well as the statement of the total number of correct and incorrect responses in the untabulated twenty trials, they would undoubtedly carry more conviction

As it is, one must ask in what respect these six trials are "typical" Surely not from the point of view of correctness, for we are already informed that by intervals of delay, between trials 180 and 200 inclusive, the choices distribute themselves as follows " for 10-minute, 1 correct, 1 incorrect, the same for 15-minute, for 20-minute, 2 incorrect, for 30-minute, 4 correct, 5 incorrect; for 45-minute, 1 correct, for 60-minute, 1 correct, 4 incorrect" There were, then, eight correct trials, five of which have been *described; and thirteen incorrect trials, one of which has been* described It is not clear then, in the light of the data presented for these trials, that the descriptions are typical in any respect save one. they tend to support the experimenter's conclusions

In general Professor Yerkes finds two sorts of positive evidence that the chimpanzee is able to respond, after an interval of at least thirty minutes' delay, to the color factor in a quadruple choice situation

1 The attitude of the subject and the characteristics of his response Under this is mentioned "the appearance of observation, comparison, and recognition and the tendency to choose, sometimes on the basis of color alone and again on the basis of color and location, the box from which food had been obtained in the previous trial"

2. The success of the response, as shown by the experimental data

He concludes: "Delayed Response to color as isolated factor, although obviously difficult for the chimpanzee, appeared convincingly after delays of at least 30 minutes This is not a limit, for our experiment is incomplete and our report preliminary and tentative"

After examination of the material which led to this conclusion, two general criticisms may now be made

1 Results which were not of a nature to support the experimenter's point of view were eliminated upon what appears to be the assumption that the factor determining the animal's responses was the factor of which the experiment was designed to prove the existence or non-existence

2 The data for twenty tests, upon which the experimenter placed most emphasis, is not presented except by way of six descriptions of behavior, five of which support the investigator's conclusion, and which we are unable to consider in connection with the other fourteen tests Had the preceding thirty tests conclusively demonstrated the ability in question this data might well have been omitted, but, under the conditions, the lack is grevious

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BOOKS

MARY M SHIRLEY *The First Two Years* Minneapolis Univ Minn Press Vol I, *Postural and Locomotor Development*, 1931, pp xv+227 Vol II, *Intellectual Development*, 1933, pp xvi+513 Vol III, *Personality Manifestations*, 1933, pp xi+228.

Psychologists who are more interested in explaining the processes of development than in merely establishing norms of behavior are turning with hope and enthusiasm to longitudinal studies of infancy and early childhood The baby diaries, which in the latter nineteenth and early twentieth centuries furnished almost the only available data either upon norms or sequences of infant behavior, are admittedly the lineal predecessors of the developmental studies which the last three or four years have brought forth It is impressive to see the contributions of pioneers like Tiedemann, Darwin, Preyer, Shinn, assuming a new valuation, and furnishing the basic observations from which investigators such as Pratt, Irwin, Bayley, Shirley, take their departure

Shirley, whose work constitutes the subject of the present review, has conserved some of the most valuable features of the diary method The babies studied by her and her co-worker, Dr Boyd, were observed in their own homes, the author taking the view that to secure records of behavior in familiar surroundings more than offset the loss in laboratory precision Visits were so frequent (daily during the first week of life, on alternate days during the second week, weekly during the first year, biweekly during the second year) that the development of new behavior patterns could be noted within a few days of their appearance Moreover, the tests and observations were checked and supplemented by daily records kept by the mothers of the babies upon specially devised schedules

While borrowing liberally from the past, the author at the same time has availed herself of the benefits of psychometric techniques, and of the invaluable backing of a research institute whose facilities were at her disposal during the painstaking collection and working up of data. Further, she has secured intensive and comprehensive growth data not upon an isolated case or two, but upon twenty-five infants The resulting work throws light upon the following important phases of development to which a collection of diaries of single cases observed from varying points of view could hardly make much contribution, and which "cross-section" studies using different subjects at different age levels could not approach at all

1. The degree of consistency with which behaviors unfold in given sequences

2. *Directional* principles of development

3 Integration and individuation of developing behavior patterns

4 The continuity of development of certain skills and functions versus the saltatory growth of others

5 The degree of persistence of developmental rates and of individual differences from child to child

6 The interrelationship of growth rates in different functions

Volume I treats the data collected upon progress toward creeping, standing, and walking, and furnishes a basis for the major conclusion that "motor development, quite apart from age, follows a pattern that has five major orders They may be described more or less adequately as (a) development of passive postural control, (b) development of active postural control, (c) active efforts toward locomotion, (d) locomotion by creeping and walking with support, (e) walking alone. Each major order of development has several stages. There is some shifting in sequence of stages within an order, but there is no transposition of a stage from one order to another The motor play of a baby at any age is in accordance with the activities of the order of development in which he is at the time" Other significant findings are (1) the cephalo-caudal direction of developing postural and locomotor control (i e, from the head down the neck and trunk to the legs), (2) predictability of age of walking alone represented by r= 80 from age of standing with help, r= 80 from age of creeping, r= 88 from age of walking with help, and zero from skills developing earlier than the 30th week, (3) suddenness of appearance of motor skills such as sitting, creeping, and walking, (4) apparent tendency for thin, muscular babies and small-boned babies to walk earlier than short, rotund babies and exceedingly heavy babies, (5) a correlation of 28 between precocity in walking and score on the Minnesota Preschool Test at 18 months, (6) a tendency toward decreased vocalization in many of the children at periods when motor acts such as reaching, sitting, and walking were being perfected

Volume II, entitled *Intellectual Development*, articulates data upon fine motor coordination with the motor data reported in Volume I, includes chapters upon the beginnings of speech, early social development, and the growth of comprehension, and devotes the bulk of space to a discussion of the batteries of psychological examinations that were administered at regular intervals The examinations included items suggested to the experimenter by the baby biographies, as well as many items taken or adapted from schedules of Kuhlmann, Gesell, Watson, Jones, Stutsman, and Wallin The full Gesell Developmental Schedule and Minnesota Preschool Schedule were also used on several occasions

As in the case of gross postural and locomotor control, the author finds evidence of consistent serial unfolding of behavior patterns, a cephalocaudal directional tendency in the development of skills, and suddenness in the emergence of many items of behavior Evidence is also presented at a few points upon the individuation of responses out of generalized activity, e g, the gradual differentiation of reaching and grasping activities from a

kind of mass activity involving thrashing movements of all the limbs

With regard to developmental rate it is found that new items of behavior emerge more rapidly during the first year than during the second, the author drawing an analogy here between differentiation of structure as opposed to hypertrophic growth during early embryonic life On the basis of point scores at successive ages the author also infers that the growth curve of mental level has a marked negative acceleration from birth to two years. The reader may question, however, whether adequate grounds for this inference are contained within the data, since the values of the point scores and the author's several derivations from these depend upon the rate of emergence of items, and this rate does not necessarily correspond to the growth rate of underlying capacities

At the time of their emergence different types of behavior—locomotion, vocalization, and manipulation—are little correlated, but signs of integration begin to show in the second year, correlation coefficients of the order of 30 to 50 being reported between developmental scores on vocalization and manipulation Individual composite scores of performance, as computed in various ways, and upon various test batteries, show very little consistency over periods of several months during the first year, but "at about 18 months the babies begin to hold their places in the group with considerable consistency" It must be remembered, however, that the babies were followed only to the age of 24 months Bayley's growth study indicates that while mental test performance maintains a greater constancy over six months intervals after the age of 24 months than before, there is a marked tendency for correlations to decrease as the interval between tests increases. This holds up to 54 months, the last age at which data have thus far been worked up

In Volume III, Shirley gathers together the data which illuminate the less intellectual, less motor aspects of behavior under the following chapter headings Irritability at Tests During the First Year, Personality as it Appears at Psychological Examinations, Personality as Expressed in Incidental Reactions, Personality as Revealed in Speech Quantitative treatment is thereafter dispensed with in favor of a three-dimensional descriptive personality study of each baby in his family background, based upon the preceding data together with supplementary observations and the author's interpretation of the whole

Records upon fussing, crying, screaming, and other vocalization, passive holding or chewing of toys, attentive, attention-getting, and escape reactions, cooperative play with children and adults, other social reactions such as watching persons, sympathy, shyness, etc., emotional demonstrations, expressive movements, and conversational content comprise the subject matter of this monograph. With such behaviors as can be scored or quantified, it is significant that all the growth curves of individual babies show the

same shapes as the curves represented by the group medians, from which the author concludes that "the course of development is just as orderly for reactions that decline and disappear with age and for those that are transitory as it is for those that become steadily more marked with age . " Consideration is also given to the question of age-to-age constancy of individual differences, but the statistical techniques here employed (particularly the "percentage of median" technique) leave this problem, we believe, in an unsettled state The reader could wish that upon all the scored personality reactions as straightforward a treatment had been used as in the case of "irritability" This trait maintains fair constancy during the first half-year as shown during both physical and anthropometric examinations, but constancy between the first and second half-years only as shown during anthropometric examinations (rank correlation=.58 between weeks 1-24, and weeks 28-52). With respect to the other personality traits, Shirley's case narratives seem to offer data which are more suggestive as to permanence of trends than do the attempts at quantitative treatment Particularly impressive are illustrations of the phenomenon called "congruence" by Vernon and Allport. "When Virginia, Ruth, Maurice, and Matthew gave up screaming, they became the most strongly addicted of the children to escaping from the examination. Similarly, Quentin's timorous crying gave way to apprehensive watching and that in turn to hiding temporarily behind his mother and being reluctant to play and talk in the examiners' presence"

The study also touches upon the problem of personality organization Apropos of "pattern," Shirley attaches much significance to the fact that "profile charts" of the different babies were so unlike in contour that the examiner could identify them without names However, "pattern" in the sense of integrated parts or Gestalt would not be a necessary condition for the examiner's success in this experiment—in fact profiles of scores on specific habits might be even easier to identify Of probably greater importance are the data, again presented through the convincing case histories, showing that certain traits such as friendliness, timidity, helpfulness, imagination, attention-seeking, are often manifested by a child in a wide variety of situations From descriptive records of this kind may be derived clues as to the nuclear traits around which personality really is built—Hartshorne and May, Newcomb, and others having demonstrated effectually that personalities cannot be catalogued, at least in general, according to certain other popular pigeonholes.

In these documents on development is a unity of viewpoint that weaves through all of the diverse materials assembled from the twenty-five infants over months of time in the varying laboratory conditions of the children's own homes This is the thesis that emergence of skills, abilities, and attitudes waits upon maturation. Although the rôle of learning in the im-

provement of performance is not denied, it is Shirley's conviction that this rôle is a very subordinate one during the first two years In support of her thesis she draws upon the following lines of evidence· the early appearance of individual differences, the child-to-child consistency of order in developmental stages, the similarity in the developmental sequences of human and animal infants, the conformity of developmental order to the anatomical law of anterior-posterior development, anecdotal data upon the apparent independence of developmental phenomena and efforts of the parents to hasten or control these

That maturation sets the upper limits of the performance of skills we can hardly doubt from the evidence of the present study and from data which the author skillfully amasses from the literature Whether learning plays so slight a rôle as Shirley credits to it might be questioned or even indignantly denied by some students of development Compare, for example, E B Holt's antithetical view that even the engrams of reflexes appearing at birth have been built in through a process of intra-uterine conditioning In regard to "personality" the author's position upon maturation and untrained tendencies is less grounded in evidence than is the case with the motor and mental behavior items. More co-twin control experiments of the type initiated by Gesell, and more studies of identical twins reared in different environments, may eventually go a long way toward solving the maturation-versus-learning problem partially answered in the present monographs

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FURTHER EVIDENCE CONCERNING COLOR BLINDNESS IN RATS

From the Psychological Laboratory of the University of Pittsburgh

NORMAN L. MUNN

INTRODUCTION

In a previous experiment (4) the writer obtained what appeared to be good evidence of color blindness in hooded rats After discriminating a colored area from a gray area of markedly different brightness, the animals were required to discriminate the color from a series of grays which gradually approximated it in brightness There was for each color a gray which the animal failed to discriminate from it. The brightness value of the color was regarded as equivalent to the brightness value of this gray. Hering yellow and Hering green were thus found to have a brightness value equivalent to Hering gray No. 7. Hering blue was equivalent in brightness value to Hering gray No 29. Hering red was equivalent in brightness value to Hering gray No 41

The animals' failure to discriminate the colors from each of the grays of the Hering series might in itself be regarded as good evidence of color blindness It is conceivable, however, that training with stimuli of different brightness might produce a *set* for brightness, this *set* preventing the animal from making a ready transition from brightness discrimination to color discrimination when brightness cues were no longer present Therefore an attempt was made to obtain discrimination between green and yellow, colors which the previous determinations had shown to be equivalent in brightness value for the rat Although 850 trials were given before the experiment was discontinued, the animals failed to manifest signs of learning. The author was thus forced to conclude that the animals were color blind, a conclusion reached several years earlier by Watson and Watson (7) who, using the Yerkes-Watson discrimination method, failed to obtain discrimination between red and green and yellow and blue after brightness cues had been eliminated

Coleman and Hamilton (1) have reported failure of hooded rats

to discriminate between red and gray, green and gray, blue and gray, and red and green when brightness differences were eliminated. They used Lashley's jumping apparatus and colored cards. Their conclusion was that "the hooded rat is unable to discriminate objects of different color, whose brightnesses are equal for the rat's own eye" (p. 181).

Anatomical evidence for the rat's color blindness resides in the fact that the cones, which are generally conceded to play an important part in color vision, appear to be absent The most recent evidence is to be found in Lashley's (3) careful study of the structure of the rat's eye

The rat's color blindness might have been regarded as an established fact but for Walton's recent investigation. The results of this investigation led Walton (6) to conclude that "colored lights may be discriminated by white rats providing the colors are not too close together on the spectrum." He said, furthermore, "If these conclusions are valid, we may be led to question the assumption that the cones are the organs of color vision, providing of course, it can be shown *conclusively* that the retina of the rat's eye is coneless" (p. 394).

Walton's rats were trained to discriminate between colors equated in brightness for the *human* eye. The colored lights which the animals were successful in discriminating under these conditions were red and green, red and blue, red and yellow, and yellow and blue They failed to discriminate between green and blue and yellow and green. This failure was attributed to the closeness of these colors on the spectrum. According to Walton, the positive results have two possible explanations: "The rats were either reacting to the color elements or to the intensities. If they were reacting to the intensities, it must mean that the lights affect the rat's eye in a manner which is different from the way in which they affect the human eye. To determine whether or not the rats were reacting to the darker or to the lighter of the two lights, a series of 30 trials was run in which the lights were made definitely different in intensity. In an irregular order the intensities were shifted about, so that 50 per cent of the time, the 'positive' color (the one to which the rats were trained to go to food) was the darker of the two lights, and the rest of the time the 'negative' color was the darker If the animal succeeded in these tests, the conclusion was drawn that it

could distinguish the colors as hues and not as intensities" (6, p. 385). The animals were not confused by these controls.

No information is given concerning the magnitude of the changes in intensity. It is reported, however, that they were produced by means of a rheostat. Since Walton did not determine the brightness value of the colors for the rat's eye, one is led to suppose that "darker" and "lighter" refer to the effect of the changes in intensity upon the human eye.

In some of the experiments to be reported in the present paper it was discovered that marked changes in brightness for the human eye failed to have any influence upon the accuracy of the rat's discrimination. Yet further tests with still larger variations in brightness showed that the response had been to brightness rather than to color differences. By making a sufficiently large change in the intensities of the lights, for example, the animal's response was reversed so that accuracy of discrimination dropped from 100 per cent to 0 per cent. Hence, to evaluate Walton's results, one would need to have information concerning the magnitude of the changes of intensity in terms of their effect upon the eye of the animal. This could be ascertained only after the brightness value of the colors for the rat's eye had been determined.

Walton was successful in obtaining discrimination between a red light and darkness. He says, in describing the nature of his controls, "*As soon as the animal had learned the problem the red was lowered* in intensity by means of a rheostat. Then the experiment was continued under dark adaptation. Each day the intensity was lowered still further until the operator found it necessary to place his hands in each passageway to tell which one was being used by the rat. Finally the intensity was so low that we had difficulty in seeing the light. The rats, although their reactions were slowed down somewhat by the changes, continued to make perfect responses" (6, p. 386). No further information concerning these changes in intensity is given. It would be interesting to know whether the intensity was decreased until the animal could no longer discriminate. The author does not say whether the red light was finally eliminated in order to determine if the rat was responding to non-visual cues.

It is difficult to reconcile this discrimination between darkness and red light of low intensity with the results of Watson and Watson (7), Coleman and Hamilton (1) and the writer (4), since these

investigators found red to have extremely low stimulating value for the rat In an unpublished study, the aim of which was to determine the spectral luminosity curve for the rat, the writer obtained further evidence of the low stimulating value of red light. The positive stimulus was a white area of low intensity, its illumination being approximately 029 f.c The negative stimulus consisted of red light (transmitted by Wratten filter No. 70) having an area equivalent to that of the white stimulus The illumination of the red area was quite low, being provided by a 100-watt daylight lamp at a distance of 114 inches Following mastery of the discrimination, the intensity of the red light was gradually increased by moving the lamp closer to the stimulus patch. Although the writer expected to find an intensity of red light which would interfere with discrimination, the greatest intensity of red obtainable in the apparatus (a 200-watt lamp placed at the point *j* in Figure 1) did not affect the accuracy of discrimination At this intensity the red light appeared to the human eye as much brighter than the white light Either the animal was responding to the red as a color or it was responding to it as still darker than the white. That the latter possibility was correct became evident when, upon elimination of the white area, the animals reversed their responses That is, instead of responding negatively to the red area as had been the case for several hundred trials, the animals now responded to it positively. It was, for the rat, brighter than darkness but less bright than the white area.

This finding, it seems to the writer, has a direct bearing upon some of Walton's positive results. The discriminations obtained by him, with the exception of that between yellow and blue, all involved red light as one of the stimuli If red has low stimulating value for the rat even at high intensities, Walton's variation of intensity might have been quite ineffective. Variations of the intensity of the red light may have been imperceptible to the animals while variations of the intensity of the lights paired with red may have been insufficient to destroy the relative brightness difference already existing—a brightness difference due to the fact that red has much lower stimulating value than any of the other colors

The positive results with yellow and blue, however, could not be explained on this basis It was partly to undertake a check on this result that the present investigation was undertaken.

The present experiment involves measurement of the brightness value of yellow and blue light for the rat's eye as well as a determination of the animal's ability to discriminate between these colors when they are of equivalent brightness to its eye

Apparatus and Method

The apparatus is a modification of the one used by Slater and Munn (5) in an investigation of the brightness vision of the white rat. It appeared well adapted to the needs of the present study Figure 1, a diagrammatic side view of the apparatus, shows the construction of the discrimination and light boxes, the mode of operation of the doors and lights, and the chief vertical dimensions.

Figure 2 is a ground plan of the light box It shows the manner in which the lights were moved back and forth to vary the intensity of the stimuli. The experimenter pulled the string on the outside of the box in the required direction until the carriage came into contact with the stop. The inside of the box was painted a dull black and the chambers were sealed to prevent leakage of light from one to the other

The chief characteristics and dimensions of the discrimination box are illustrated in Figure 3 This apparatus was constructed from three-ply wood The entire inside of the discrimination box, with the exception of the stimulus patches, was covered with black velvet This effectively destroyed differential reflection of the light from the stimuli The stimulus patches consisted of milk glass ⅛ inch in thickness Over a single sheet of milk glass 12 inches by 6 inches in size was placed a sheet of metal from which two 5-inch squares had been cut The upper surface of the sheet of metal was covered with black velvet No light entered the discrimination chamber except that transmitted by the two 5-inch squares of milk glass.

The colored stimuli consisted of the squares of milk glass upon which light transmitted from Wratten filters was projected The light was projected upon the under surface of the glass by means of the mirrors shown in Figure 1. The filters were inserted in the stimulus panel, *j*, between the 150-watt daylight lamps and the mirrors. The standard white stimulus patch was obtained by projecting the light from a 150-watt daylight lamp upon the under side of the milk glass, a sheet of plain glass appearing in the stim-

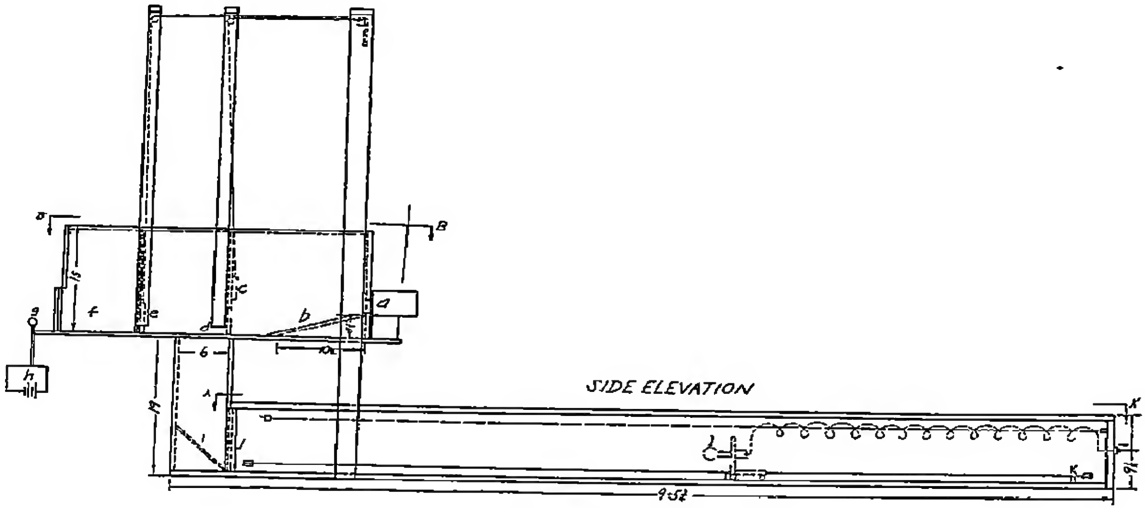

FIGURE 1

SIDE VIEW OF THE APPARATUS

The animal enters the discrimination chamber from the box *a* and runs down the incline, *b*, toward the illuminated patches at *d*. These patches of light are in the floor of the apparatus and the animal runs over them. Following an incorrect response, the door, *c*, is dropped, confining the animal to the chamber above the incorrect stimulus patch. The same door is sometimes dropped to prevent the animal from returning into the discrimination chamber after making a correct response. Following a correct response the door, *e*, of the chamber above the correct stimulus patch is opened to admit the animal to the food box, *f*. This box is dimly illuminated by means of the bulb, *g*, from which it is separated by frosted glass. *h*, dry cell batteries. A single sheet of translucent milk glass, covered by a sheet of metal from which two 5" squares had been cut, appears at *d*. The mirror, *i*, throws the light transmitted by the filters at *j* upon the under side of the translucent glass screen. The stimulus panel, *j*, serves to exchange the right-left positions of the filters. The light, *l*, and its carriage, whose wheels run along strips of metal, are moved back and forth by means of pulleys and cords, the adjustable stops, *k*, indicating the required positions.

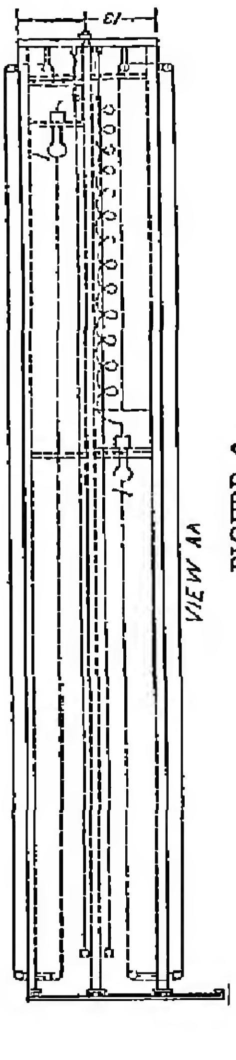

FIGURE 2

GROUND PLAN OF THE LIGHT BOX

The 150-watt lamps, *l* and *l'*, were matched by means of a Macbeth illuminometer The stimulus panel, *s*, served to move the filters from one side of the light box to the other.

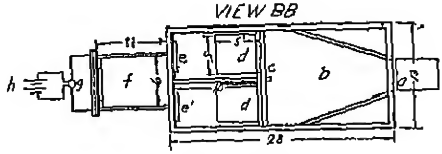

FIGURE 3

GROUND PLAN OF THE DISCRIMINATION BOX

The rat entered the discrimination chamber from the box, *a*, in which it had been conveyed to the front of the apparatus from the food box or confinement chamber After emerging from this box, the animal ran down the incline, *b*, toward the stimulus patches, *d* and *d'* The diagonal walls of the discrimination chamber were to prevent the animal from consuming time in exploration of the corners After a correct response, the door *e* or *e'* was opened, admitting the animal to the food box, *f* Immediately following an incorrect response, the door *c* was dropped This door confined the animal to the chamber above the incorrect stimulus The door was sometimes used to prevent the animal from returning into the discrimination chamber after a correct response. The bulb, *g*, dimly illuminated the food box from which it was separated by frosted glass

ulus panel. The 150-watt daylight lamp was at a distance of 76 inches from the stimulus patch.

The Wratten filters used in this investigation were No 73 (yellow green) and No 75 (blue green) These filters gave a good yellow and a good blue when the light transmitted by them was projected upon the milk glass Their spectrophotometric absorption curves are reported in the Eastman Kodak pamphlet entitled *Wratten Light Filters.* The yellow filter was used at normal transmission while the blue was covered with two thin sheets of wax paper. The illumination of the colored areas can be given only indirectly, since we possessed no means of measuring the illumination of colored light As will be seen from the tables to be presented later, the distance of the lamp from the stimulus patch is reported in each case This is all that was necessary for the present purposes. The illumination of the standard white area was .029 foot candles as measured by means of a Macbeth illuminometer.

A quiet room was used for the experiment and the only illumination came from the stimulus patches and the small lamp which served to illuminate the food box. The animals were kept in the same room. The room was darkened several hours before the daily trials began and the cages were covered during the experiment in order to insure a given state of adaptation at the beginning of the

trials Ten trials per day were given The animals were fed a daily ration consisting of two pieces of Purina Dog Chow. Once a week they received a supply of lettuce.

After they had become adapted to the apparatus and general procedure, the animals were required to discriminate the standard white area from the colored area by responding to the former. The colored area was at first quite dim, the white area being definitely brighter. When the discrimination had been mastered, the intensity of the colored area was increased. Its intensity was increased in large units at first and then in smaller and smaller units as the threshold was approached When the animal's accuracy fell below 80 per cent in 10 trials, the intensity was decreased and a further determination made This was continued for a number of series of 10 trials each until the intensity of the colored area which could be discriminated from the white area with an accuracy of approximately 80 per cent was determined. Further details concerning these procedures appear in the report of results

The animal was rewarded immediately following a correct response, the experimenter opening a door which admitted it to the food box In the food box it was allowed to nibble at a piece of Purina Dog Chow until picked up and placed in the entrance box. The entrance box was then carried to the front of the apparatus and its opening placed against the opening of the discrimination chamber Following an incorrect response, which consisted in placing the two front feet on the incorrect stimulus patch, a door was dropped which confined the animal to the compartment containing this patch Usually the animal ran right across the stimulus patch in making an incorrect response There were a few trials, however, in which dropping of the door did not confine the animal In these instances the animal was picked up from the discrimination chamber and dropped into the chamber over the incorrect stimulus patch The rat was always removed from this chamber before changes in the position of the stimuli were made No food was given after an incorrect response

Precautions against the use of extraneous cues were observed throughout the experiment The experimenter was hidden from the animal's view by means of a screen, operation of the doors of the discrimination box occurred *after* the animal had made its response, having the food equidistant from the stimuli excluded olfac-

tory cues; use of a box to convey the animal from the food box or confinement chamber to the entrance of the discrimination box minimized possible handling cues; a chance order of presentation of the stimuli prevented discrimination upon the basis of position habits, and the distance of the lamps from the stimulus patches prevented the animals from discriminating temperature differences. Additional controls to test whether the unavoidable noise associated with changing of the position of the filters and variation of the distance of the lamps aided the animal led to negative results. The fact that a point was eventually reached where the animals failed to maintain their discrimination was sufficient proof that secondary cues were not being used as a basis of discrimination.

Results

The Brightness Value of Yellow for the Rat's Eye The yellow, as already indicated, was obtained by passing light through Wratten filter No. 73. Little difficulty was experienced in obtaining the initial discrimination between white and a low intensity of yellow, since the animals had already been trained to discriminate the standard white area from red which, as already indicated, had a very low stimulating value. The results are summarized in Table 1.

TABLE 1

DETERMINATION OF THE BRIGHTNESS VALUE OF YELLOW FOR THE RAT

The area of each stimulus patch was 25 sq in. Illumination of the standard white area (positive stimulus) was approximately 029 f c The table shows the percentage of correct responses for the number of trials indicated in the parentheses.

Rat	Distance of 150-watt lamp from colored stimulus patch				
	114"	114-64"	57"	51"	47"
1	94(50)	83(90)*	78(50)	58(50)	50(10)
2	90(50)	88(70)	84(50)	56(50)	20(10)
3	100(50)	100(60)	86(50)	72(50)	50(10)
4	96(50)	90(80)	78(50)	58(50)	40(10)

*These figures summarize the results of an approximation series carried to the point where evidence of proximity to the threshold was obtained The figures in the parentheses do not necessarily indicate consecutive trials. A series of 10 trials in which the animal made two or more errors was followed by retraining on the intensities previously discriminated A further test was then given. These figures summarize the results of all trials, including retraining

Examination of the table shows that a high degree of accuracy was maintained until the lamp behind the colored area was moved to within 64 inches of the area. If an accuracy of approximately 80 per cent in 50 trials is taken to represent threshold discrimination, such a threshold was approximated when the lamp was at 57 inches. A lower criterion of threshold discrimination would place the position of the lamp between 57 and 51 inches. For the purposes of the present investigation, however, the higher criterion was regarded as more reliable, since it would minimize the influence of chance factors. This was important because of the desire to obtain comparative data on the brightness threshold from two separate discriminations, in this instance yellow *vs* white and blue *vs* white

The Brightness Value of Blue for the Rat's Eye. The blue light was, as already indicated, obtained by means of Wratten filter No 75 The white area was that used in the previous determination This discrimination was undertaken immediately following completion of the yellow-white discrimination. Since the blue was at low intensity, the animals responded with very little training to the white area Table 2 summarizes the results.

TABLE 2

DETERMINATION OF THE BRIGHTNESS VALUE OF BLUE FOR THE RAT

The area of each stimulus patch was 25 sq in The illumination of the white area was approximately 029 f c The table shows the percentage of correct responses for the number of trials indicated in the parentheses

Rat	Distance of 150-watt lamp from colored stimulus patch 114"	114-106"	99"	94"	84"
1	96(50)	92(50)*	85(40)	77(40)	50(10)
2	94(50)	90(50)	70(50)	50(30)	——
3	92(50)	86(50)	78(50)	60(40)	——
4	98(50)	92(50)	80(40)	80(40)	65(20)

*See footnote to Table 1

Discrimination of the white area from the blue area was maintained with a high degree of accuracy until the lamp behind the latter area was at a distance of 106 inches. The closest approximation to an accuracy of 80 per cent in 50 trials came when the lamp was 99 inches from the stimulus patch.

Comparison of these results with those for yellow shows that the blue and yellow were approximately equivalent in brightness for

the rat when the lights were, respectively, 99 inches and 57 inches from the stimulus patches. This result indicates that the light from the blue filter, especially since its intensity had already been reduced by means of two sheets of wax paper, was for the rat much brighter than the light from the yellow filter. It might be mentioned, furthermore, that for the human eye this relationship was reversed, the yellow appearing much brighter than the blue.[1]

Discrimination of Colors Equated in Brightness for the Rat's Eye The rats with which the above determinations were made, together with four untrained animals, were required to discriminate between blue and yellow, the lamps being 99 inches and 57 inches, respectively, from the stimulus patches. They were required, in other words, to discriminate between colors approximately equivalent in brightness value for their own eyes. Five of the animals were required to respond positively to the blue area while the others were trained to make a similar response to the yellow area Two of the rats used in the above determinations appeared in each group.

TABLE 3

DISCRIMINATION OF COLORS EQUATED IN BRIGHTNESS FOR THE RAT

The yellow and blue areas were 25 sq in A 150-watt daylight lamp was 99" from the blue area and 57" from the yellow area

	Percentage correct in successive groups of 50 trials									
Rat*	50	100	150	200	250	300	350	400	450	500
1	50	42	42	40	40	50	50	58	60	58
2	58	54	50	70	62	52	60	64	58	52
3	46	50	54	54	54	52	36	54	54	48
4	62	72	50	56	50	48	48	52	50	52
5	48	50	44	48	58	54	60	48	56	54
6	58	56	62	48	62	42	48	54	62	54
7	50	58	52	50	50	52	44	40	38	50
8	56	50	46	54	50	54	58	50	62	58

*Rats 1, 2, 5, 6, and 7 were trained to respond positively to blue while rats 3, 4, and 8 were trained to respond positively to yellow

[1]Graham (2) has obtained similar results with these filters He determined the spectral visibility curve for the rat's retina by measuring the electrical retinal response This curve shows blue green (filter No 75) to have the greatest stimulating value and orange red (filter No 71A) the lowest Yellow green (filter No 73) possessed a stimulating value much lower than blue Graham's results and those of the present investigation, as far as they go, show that the spectral luminosity curve of the rat closely approximates that found for the totally color blind human eye Graham's data show no evidence of a Purkinje effect.

There was no difference in the accuracy of response, however, for those animals with previous training and those without training Likewise the accuracy of the animals trained to go to the yellow area did not differ from that of the animals trained to go to the blue area. The results are summarized in Table 3

None of the animals manifested any evidence of discrimination This result indicates clearly not only that the animals were color blind for yellow and blue light but that the brightness thresholds determined above were approximately correct Should any of the animals have mastered the above discrimination, it would have been quite easy, upon the basis of the data on brightness thresholds, to make further changes in brightness known to be effective for the rat's eye

The readiness with which Walton's animals discriminated between blue and yellow of equal brightness to the human eye, coupled with the present failure to obtain discrimination of these colors when they were equated in brightness for the rat's eye, led the writer to undertake the following investigation of the rat's ability, under the general conditions of the present experiment, to discriminate between the yellow and blue stimuli of approximately equal brightness for the human eye If the animals should learn the discrimination, it would be easy, upon the basis of the above threshold determination, to ascertain whether the response was to color or to brightness.

Discrimination of Colors Approximately Equal in Brightness For the Human Eye To approximate the brightness of the colors for the human eye it was necessary to make a large increase in the intensity of the blue and a large decrease in the intensity of the yellow. Such an approximation was achieved when the 150-watt lamp was moved up to a point 57 inches from the blue area and back to a point 99 inches from the yellow area Two animals which had already been given 100 trials on the above discrimination, but which had shown no signs of learning it, were required to discriminate between blue and yellow under these conditions The results are shown in Table 4

The difference between these results and those obtained with colors of equivalent brightness for the rat is quite marked Evidence of discrimination was present within 50 trials for one rat and within 150 trials for the other. That the discrimination was

TABLE 4

DISCRIMINATION BETWEEN BLUE AND YELLOW OF APPROXIMATELY EQUAL BRIGHTNESS FOR THE HUMAN EYE

The stimulus patches possessed an area of 25 sq. in The 150-watt lamp was 57″ from the blue area and 99″ from the yellow area

Rat	Percentage correct in successive groups of 50 trials 50	100	150	200	250
9*	50	68	74	88	100
10	80	74	80	88	90

*Rat 9 responded positively to blue, Rat 10 to yellow

based on brightness differences rather than color differences is, however, clearly shown by the controls summarized in Tables 5 and 6.

TABLE 5

CONTROLS FOR RAT NO. 9

No of trials	Percentage correct	Nature of control
20	95	Intensity of yellow increased—both lamps at 57″.
10	70	Intensity of blue decreased—both lamps at 99″.
10	0*	Intensities reversed—blue with lamp at 114″ and yellow with lamp at 34″
70	60	Equated for rat's eye—lamp 99″ behind blue and 57″ behind yellow
50	44	Blue slightly decreased in intensity, i e, lamp moved back to 114″ from 99″. Yellow at 57″ as above.
100	94	Retraining trials—10 trials with areas equated in brightness for human eye followed each control series in which accuracy fell below 80 per cent

*The animal went to yellow at every trial although it had just previously made a series of 10 perfect responses to blue With the intensities as in the original training (equated for human eye) there were 10 perfect responses to blue immediately following this control

TABLE 6

CONTROLS FOR RAT NO. 10

No of trials	Percentage correct	Nature of control
10	90	Intensity of yellow increased—both lamps at 57″
10	100	Intensity of blue increased—lamp 34″ from blue Intensity of yellow decreased—lamp 114″ from yellow
10	0*	Intensity of blue greatly decreased (50 watt lamp substituted for 150-watt and placed at 114″) and that of yellow increased (150-watt lamp at 57″)
70	60	Equated in brightness for rat—lamp 99″ from blue and 57″ from yellow
50	54	Blue slightly decreased in intensity—lamp moved from 99″ to 114″ Yellow still at above intensity.
100	89	Retraining trials—10 trials with areas equated in brightness for human eye followed each control series in which accuracy fell below 80 per cent

*The animal went to blue at every trial although it had just responded to yellow with an accuracy of 100 per cent in 10 trials With the areas equated in intensity for the human eye there were 10 consecutive responses to yellow immediately following this control.

The two initial controls show that large changes in the intensity of the stimuli could be made without significantly affecting the accuracy of response. An extremely large change in the intensities, such as to reverse the direction of the brightness difference, led to a reversal of response The animal which had been responding to blue now went to yellow and the one which had been responding to yellow went to blue. Seven separate determinations of 10 trials each were made with brightnesses equated for the rat's eye. At least 10 retraining trials were given between each of these determinations Usually the animal, although its accuracy fell to a low point during the control, responded with a high degree of accu-

racy in the 10 subsequent trials. In successive determinations with the colors equated for the rat's eye in accordance with the data of Tables 1 and 2 there was some evidence of improvement. For example, Rat No. 9 manifested the following accuracies for seven consecutive determinations: 50, 30, 60, 60, 80, 60, 80 This gave an average accuracy of 60 per cent However, the higher percentages toward the end of the series appeared to indicate that the animal might be learning to discriminate Following a slight decrease in the intensity of the blue, the following consecutive percentages were obtained 30, 50, 50, 40, 50. Similar results were found for the other rat; hence it appears that the improvement was due to a slight brightness difference which the animals were attempting to discriminate and which the further adjustment of the intensities eliminated During the retraining series there was, as already indicated, a high degree of accuracy This accuracy approximated 90 per cent

Summary and Conclusions

The brightness value of yellow and blue light for the eye of the white rat was determined by finding an intensity of each color which the animals could discriminate from a white area of standard intensity with an accuracy of approximately 80 per cent in 50 trials Such a determination showed blue to possess a much higher stimulating value than yellow The rats failed to discriminate between yellow and blue areas of equal brightness for their own eye They learned readily to discriminate between yellow and blue when these colors were approximately equated in brightness for the human eye. Subsequent control of brightness indicated that the animals had been responding to the brightness difference rather than to the wave-length difference. Although the intensity of the stimuli could be varied over a wide range without interfering with the accuracy of discrimination, an extreme variation, such as reversal of the direction of the brightness difference, led to reversal of response The animal which had previously gone to blue, for example, now responded to yellow, the negative stimulus When the colors were equated in brightness for the rat's eye, accuracy of response dropped from approximately 100 per cent to approximately 50 per cent.

The results of this experiment support the previous findings of Watson and Watson (7), Coleman and Hamilton (1), and the

writer (4). They are supplemented, furthermore, by the fact that the rat's retina appears to be coneless and by the nature of the spectral visibility curve for the rat's retina as determined by Graham (2) These results do not support Walton's conclusion to the effect that rats discriminate color differences

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DE NOUVEAUX TÉMOIGNAGES SUR LE DALTONISME CHEZ LES RATS

(Résumé)

On a determiné la valeur de clarté de la lumière jaune et bleue pour l'oeil du rat blanc au moyen de trouver une intensite de chaque lumière laquelle les animaux ont pu distinguer d'une lumière ordinaire blanche avec une precision d'environ 80 pour cent dans 50 épreuves Ces déterminations ont montré que la lumière bleue possede une valeur beaucoup plus stimulante que celle possédee par la lumière jaune Quand on a exigé une discrimination entre le jaune et le bleu d'une clarté équivalente à l'oeil du rat, les animaux ne l'ont pas apprise dans 850 épreuves Ils ont appris entre 50 à 100 epreuves, cependant, à distinguer entre ces couleurs à une clarté équivalente à l'oeil humain Des contrôles subséquents de la clarté ont indiqué que les animaux avaient répondu à la différence de clarté plutôt qu'a la différence de couleur Bien qu'on ait pu faire une grande variation dans l'intensité des lumières sans deranger la précision de la discrimination, le renversement de la direction de la différence de clarté a causé le renversement de la réponse un animal qui avait répondu positivement au bleu a répondu positivement au jaune maintenant, et vice versa

D'ailleurs, l'égalisation de la clarté des lumières pour l'oeil du rat en termes des résultats antérieurs a causé une perte complète de la discrimination. Les résultats de l'investigation amènent la conclusion que le rat blanc est aveugle au jaune et au bleu comme couleurs.

MUNN

WEITERE EVIDENZ BEZÜGLICH DER FARBENBLINDHEIT BEI RATTEN

(Referat)

Der Helligkeitswert des gelben und blauen Lichtes fur das Auge der weissen Ratte wurde durch die Aufdeckung einer Intensitat fur jede Farbe festgestellt, die die Tiere von einem Normalweisslicht bei einer Genauigkeit von ungefahr 80 Prozent in 50 Proben unterscheiden konnten. Diese Ergebnisse zeigten, dass das blaue Licht einen viel hoheren Anreizungswert besitzt als Gelb. Wenn die Unterscheidung zwischen Gelb und Blau von gleichwertiger Helligkeit fur die Augen der Ratte verlangt wurde, gelang es den Tieren in 850 Proben nicht zu bemeistern. Sie lernten aber in von 50 bis zu 100 Proben zwischen Farben von gleichwertiger Helligkeit für das menschliche Auge unterscheiden. Nachherige Kontrollen der Helligkeit zeigten, dass die Tiere auf die Helligkeitsverschiedenheiten anstatt auf die Farbenverschiedenheiten reagierten. Obgleich eine grosse Variation der Starke der Lichter stattfinden könnte, ohne die Genauigkeit der Unterscheidung zu storen, fuhrte eine Untersuchung der Richtung des Helligkeitsunterschiedes zu einer Vertauschung der Reaktion, d.h., ein Tier, das positiv auf Blau reagiert hatte, reagierte jetzt positiv auf Gelb, und umgekehrt. Im übrigen fuhrte die Ausgleichung der Helligkeit der Lichter fur die Augen der Ratten in bezug auf fruhere Befunde zu einem vollkommenen Verlust der Unterscheidung. Die Ergebnisse der Untersuchung leiten uns zur Folgerung, dass die weisse Ratte blind fur Gelb und Blau als Farben ist.

MUNN

CONDITIONED RESPONSES IN THE WHITE RAT*

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INTRODUCTION

The present paper describes the behavior of the white rat as a function of a very simple but precisely controlled "conditioned response type" of situation. The development of a satisfactory conditioning technique, and the description of the responses established through its use, are important in themselves. The conditioned response seems worth studying both for its own sake and as a "tool" for measuring sensory capacities, etc. Equally important, however, is the application of the results of the present paper to general theories of learning. A brief review of the current theories in regard to the relationship between the conditioned response and other forms of learning will be presented to make this point clear

A number of writers have attempted to describe learning in complex situations as an elaborate series of conditioned reflexes or responses This is not the place to list all such attempts, but those of Guthrie (1), Hull[1] (4, 5, 6, 7, 8), and Hunter (9) may be mentioned as typical. Others have objected to such a procedure, among them Tolman (23), Hilgard (2), and Lashley (11). This difference of opinion may be shown rather nicely by quoting two statements from successive chapters in *The Foundations of Experimental Psychology.* Lashley states in his chapter:

> The evidence from many lines of investigation opposes interpretation of learning as the formation of definite "conditioned-reflex arcs" through the cerebral hemispheres or through any other part of the central nervous system. (11, p 561)

Hunter concludes the next chapter as follows.

> The present chapter has not afforded an opportunity for

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[1]Since this was written, a conversation with Professor Hull has led the writer to doubt that this statement fits Hull's present views

> a detailed presentation of the work upon conditioned reflexes Had such an opportunity been available, the conclusion would have been suggested that all learning is fundamentally of the conditioned-reflex type and that analysis of the detailed mechanics of the learning process must be based upon detailed physiological experimentation (9, p 622)

The term "conditioned reflex" has acquired several meanings. It is clear that the writers quoted above are not referring to the complex findings of Pavlov, based on the slow secretion of saliva, nor are they referring to the conditioned verbal reactions, studied recently in Bechterev's laboratory They are referring to the simplified, partly conceptual conditioned reflex of the American psychologist. In its most typical form, this would probably consist of a sharp response of skeletal muscle, occurring several hundred sigma after the conditioned stimulus The conditioned knee jerk, eyelid reaction, and hand withdrawal appear to be actual examples of this type of conditioned reflex However, upon closer examination, these conditioned responses lose their simplicity When carefully recorded, they seem to fall roughly into two groups. The first reactions to appear in response to the conditioned stimulus often do not resemble the original unconditioned response, and may be characterized as "preparatory" responses After further training, responses more nearly like the unconditioned ones may be obtained. Accurate recording has shown these more "typical"[2] conditioned responses to differ from the unconditioned ones in latency, duration, and amplitude (2, 18, 27). Such differences are to be expected, since the conditioned and unconditioned stimuli must effect different receptor and neural mechanisms These differences are often neglected through the somewhat ambiguous use of the word "response" in discussions of learning theory

Another important way in which the actual conditioned response of the laboratory differs from the theoretical one is likewise neglected. A few double stimulations are usually assumed to account for conditioning. Actually a hundred or more presentations are often required to establish a sharp short-latency conditioned response. Even under favorable conditions the progress of conditioning is most irregular. The writer has discussed this matter in a

[2] "Typical" in the sense that they resemble the simplified conditioned response of learning theory

previous paper (19), and there suggested that the difficulty might be due, in part, to complications introduced by verbal processes peculiar to man.

It would seem highly desirable, therefore, to observe the behavior of a lower mammal in a conditioned response situation of the type described above Perhaps the nearest approach to such an opportunity is furnished by the experiments of Warner (26) He placed white rats in a number of different situations, and then repeatedly presented a sequence of stimuli consisting of a buzz or light, followed after a one-second interval by a shock. The responses ultimately elicited by the buzz or light varied greatly from animal to animal, but never closely resembled the original response to shock. The responses observed by Warner may be described more accurately as "preparatory" (as bracing for a jump), and "consummatory" (as jumping *over* a fence) rather than as "conditioned" (which would have resembled the original response to shock, i e., crawling *under* the fence) One may argue that the complexity of the results was due to the complexity of the situation, for the rat was not restrained. The cage, etc, which held the animal remained constant as an object in space, but the rat was free to move in it, thus receiving varied stimulation.

The Problem

The aim of the present investigation may now be stated more precisely. An attempt will be made to establish a conditioned response approximating the "typical" one described above. To avoid the complicating effects of verbal processes, the white rat will be used. The use of this animal is further indicated by its convenience and its wide employment in maze studies The external stimuli will be carefully controlled and the responses limited by a holder.

A large portion of the work to be reported was devoted to the systematic variation of certain factors, in an attempt to obtain a satisfactory technique for establishing conditioned responses. It would lead to confusion to present the specific conditions for each rat under one heading and the results separately under another. Therefore the general method will be described first, next apparatus, and then the responses observed We will then consider the specific variations in technique and their effects on the develop-

ment of conditioned responses Finally, certain general observations will be presented, and the results discussed.

The General Method

The unconditioned stimulus was always a shock delivered near the end of the tail. The responses recorded were breathing, tail movement, and squealing The tail was chosen as the site of the shock, partly because of its accessibility for stimulating and recording, and partly because of its isolated position. The writer had hoped to anaesthetize or remove part of the tail after conditioning was complete, and thus attempt to verify Lang and Olmsted's (10) study of the effects of the unconditioned pathway on the conditioned reflex. Unexpected difficulties in establishing conditioning forced the writer to postpone this part of the experiment, and to concentrate on the development of a satisfactory technique of conditioning and a description of the behavior observed.

The conditioned stimulus, a buzz or a light, was started 335 sigma before the shock, and continued with it for an aditional 165 sigma. This interval is shorter than that usually used with infrahuman animals, but the writer does not know of an experiment that shows the optimal interval Several studies show that one-third second is in the best region for comparable reactions in man (29) Since the general reaction time of the rat, as determined in preliminary experimentation, is about .1 seconds, the interval chosen permits the rat to respond before the shock On the other hand, a longer interval, or a variable one, might be expected to lead to difficulties in a situation designed to call out a sharp response, rather than a prolonged one, as salivation, and might also favor complicated intercurrent responses

Apparatus

A schematic wiring diagram is presented (Figure 1). It may be seen that the situation is not as simple for the experimenter as it is for the rat. The holder for the rat consisted of a low-walled box, into which telescoped an inverted cage. The box was constructed by fastening front and side walls of Prestwood to a block 2⅞ inches wide, 1⅞ inches thick, and 23 inches long. The walls projected 1¾ inches above the top of the base, and ran halfway down the length of it The remaining half of the base supported

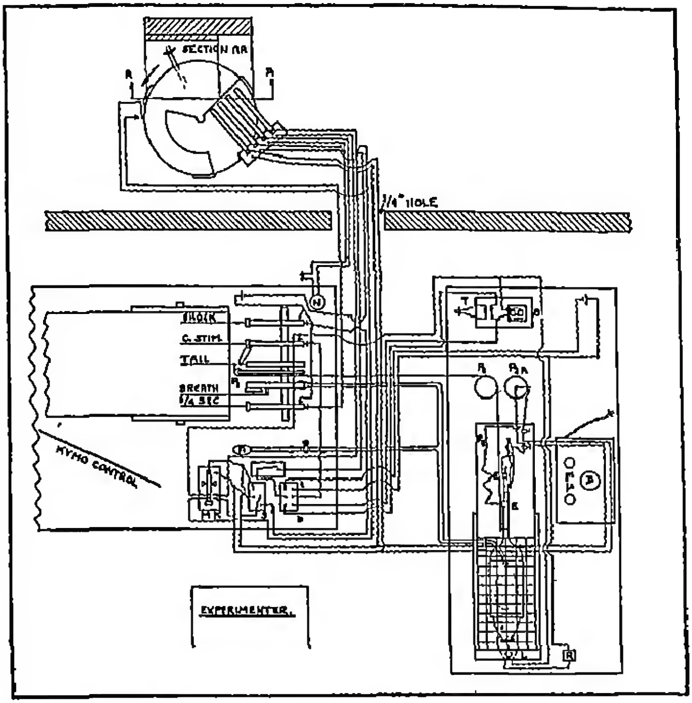

FIGURE 1

KEY

Left side

Section AA—of timer

N—Neon bulb
Markers as labelled
P1—Pulley

A—Pressure bulb of air system
MK—Master key
S—Shock position of switch
l—Light position of switch
b—Light position of switch

Right side

T—Transformer ("bell-ringing")
B—Buzzer
P2—Pulley
P2a—Pulley with short-circuiting contacts
R2—500,000-ohm resistor

E, E—Electrodes
ES—Electro-stimulator

L—Light

R—Rheostat to control light

All paired wires shown terminating in plugs were connected to the 110-volt, 60-cycle lighting circuit, through appropriate switches For further explanation, see text

the tail The inverted cage was a coverless box, 2½ inches wide, 6¾ inches long, and 2½ inches deep, constructed of ½ inch galvanized mesh, with a slot cut in back to allow the tail to project. A metal shield, lined with a rubber balloon, was fastened to the rat's back by means of a wire loop under the neck, and a thong under the abdomen. The rat was then placed in the holder, and further restrained by rods slipped through the mesh cover. The rods held the shield firmly in contact with the rat, regardless of size, and were quite essential to keep him from turning over A length of rubber tubing led from the balloon to a recording tambour, with a Cellophane membrane (21) A bulb and stop-cock were attached for control of the pressure in the air system. This arrangement is quite sensitive, and undoubtedly yields records of gross bodily movements as well as breathing It would have been extremely difficult to eliminate the effect of movements other than those involved in breathing, but it was not considered particularly essential. The Cellophane membrane is not materially affected by increased pressure after it has stretched a trifle, so struggling caused no trouble with the recording apparatus. The first membrane installed has been used fairly continuously for a year.[3]

Tail movements were recorded with a light muscle lever, using a rubber band as counterpoise A thread passed from the lever over two pulleys and was attached to the base of the tail by a hook and adhesive tape. Time was usually recorded in ¼ seconds, and a 60-cycle time line was sometimes added (20). All records were taken on a Harvard extension kymograph, modified to be driven by a G. E. induction disc phonograph motor This arrangement gave a range of speeds of from 1/16 to 1 inch per second. Twenty-five stimulations could be recorded conveniently on a 7-foot belt The control lever, operating a centrifugal governor, made any speed within this range available. All markers were mounted on one pivoted rod and clamp system to facilitate their even adjustment. After the records had been taken they were always retraced, and simultaneous ordinates added at the point of stimulation by each shock, or, when the shock had been omitted, at the beginning of

[3]Since the completion of the experiment reported here, the original membrane has been replaced by one of "waterproof" Cellophane The latter membrane is not affected by changes in humidity

the buzz or light. These ordinates greatly facilitate the detection of early responses.

A shock to the tip of the tail was used as the unconditioned stimulus Two clip-like electrodes were made of strips of spring brass, ⅜ inch in width, and fastened around the tail one and two inches respectively from its end Strips of velvet, saturated with Ringer's solution, were placed under the clips to give good contact (the fine hairs on the tail keep metal from touching the skin and act as efficient insulators if wet cloth is not used). To prevent current leakage across the electrodes, tail and clips rested on a dry glass plate The current for the shock was furnished by the following arrangement Current from a toy transformer, after passing through a potentiometer, was "stepped up" by a Ford (model T) coil. It was then rectified by a vacuum tube, and passed through a milliammeter and two wire-wound resistors before reaching the electrodes. A 50,000-ohm resistor was built into the apparatus, and clips for a second resistor (usually ½ megohm) were placed near the electrodes The strength of the shock was regulated by adjusting the potentiometer, or, when a very strong shock was necessary, by using smaller resistances in the clips Usually a current of 2 milliamperes, flowing through a total resistance of about 600,000 ohms, was sufficient The shock was presented by momentarily opening keys shorted across the output of the shocking apparatus These keys always left the large resistor in series with the tail, to minimize the possibility of shock through induction In addition to the timer and associated key and switch, an additional unit was used with some rats This consisted of a pair of contacts attached to one of the pulleys, so arranged that the first millimeter of movement of the rat's tail would short-circuit the current Additional movement of the tail caused the recording thread to slide over the pulley, but the moment the tail started to return to its normal position, the circuit opened again.

Two conditioned stimuli were used, a buzz and a light. The buzz was furnished by an ordinary buzzer, with automatic interrupter removed, actuated by a small transformer Both were mounted on a board and placed two feet behind the rat. Both holder and board were insulated from the table by rubber and felt, to eliminate vibrations The buzzer, when connected in the manner described above, was very constant and even. The light was

furnished by a 2.2-volt flashlight bulb, reflector, and lens, placed about an inch from the rat's nose. A storage cell and rheostat were used to furnish the current. A switch was arranged to throw either light or buzzer in circuit with the timer and signal marker The same marker was used for both, but the buzz can readily be differentiated from the light on the records by the presence of A. C. pulsations in the former.

The duration of all stimuli was determined by a timer. An Allen-Hough synchronous phonograph motor and turntable was used for this purpose. This motor was chosen because it makes 80 r p m., rather than the usual 78, and thus makes possible a ¼-second time line Three two-inch lugs were attached to the edge of the disc, and actuated light platinum contacts, which, in turn, actuated a time marker. Sectors of Prestwood, fastened to the top surface of the turntable, controlled both conditioned and unconditioned stimuli through appropriate contacts. Separate contacts were used for shock and its marker, so that the high-voltage current would not be diverted through the coils of the marker. The weakness of the motor necessitated the use of very light contacts, with celluloid facing on the lugs This difficulty was more than overbalanced by the constancy of the synchronous motor, driven by regulated A C. The size of the raised segments was such that the conditioned stimulus was presented alone for 335 sigma, and then *in company with the shock for 165 sigma. Both were then terminated.* The motor was placed in an adjoining room, and operated constantly during an experimental sitting. To permit the presentation of one sequence of stimuli at appropriate intervals, it was necessary to arrange a multiple key in the experimental room This was made from a pivoted hard rubber strip, carrying screws that dipped into mercury cups. It was padded with rubber, and was quite noiseless An additional contact on the timer lighted a Neon bulb, and permitted the experimenter to synchronize his actions with the timer Appropriate knife switches permitted the omission of either stimulus from the sequence. All controls were near the recording end of the kymograph, for convenience The rat was on another table, at the right of the experimenter. All experiments were performed in a quiet room on the third floor of the animal laboratory. An elaborate sound-resisting box was available, but for the present experiments it was thought better to have the animal under con-

stant observation This was ultimately found to be true, for the conditioned squealing described later would not have been observed if the box had been used Visual cues were eliminated by covering the front end of the holder with dark velvet Sound cues were minimized by padding the markers with adhesive tape Control tests have shown that these measures were adequate for the present problems Later experiments may necessitate the use of the sound-resisting box

The Behavior

In general, the rats were fairly quiet in the holder. They sometimes became excited and struggled, particularly during the first experimental period, or when strong shocks were used There was considerable variation from rat to rat in this characteristic. Some of the experimental group were placed in duplicate holders for several half-hour periods, to accustom them to being restrained This seems to have diminished the struggling during the first experimental periods When the rat was not struggling, its breathing was regular, and took one of two forms The records show one type to be rapid (3 or 4 breaths per second) (Figure 2, Rat 04, A, B, and C) and rather sigmoid in form, and the other to be slower (1 breath per second) with most of the delay occurring in the second half of the expiratory phase (Rat 13, A, B, and C) (Rat 03, B, and C) Breathing records were sometimes obtained that could not readily be classified under either of these two headings, but they were relatively infrequent The slow breathing was, in general, typical of the animal at rest, and changed abruptly to rapid breathing upon stimulation This shift occurred quite frequently in response to the buzz before training, and less frequently to the light The buzz occasionally called forth a deep inspiration in some rats The response to shock was much more violent It showed on the records as a sharp, deep, sustained inspiration, and tail withdrawal (Rat 03, 04, A) Two distinct pulls of the tail in rapid succession were often observed One or more squeals were almost invariably emitted by the rat. It seemed impractical to record these directly on the kymograph, so they were noted on the stimulation schedule, in a blank left for the purpose They could usually be correlated with a plateau on the breathing record In addition to the actual breathing movements, other bodily

FIGURE 2

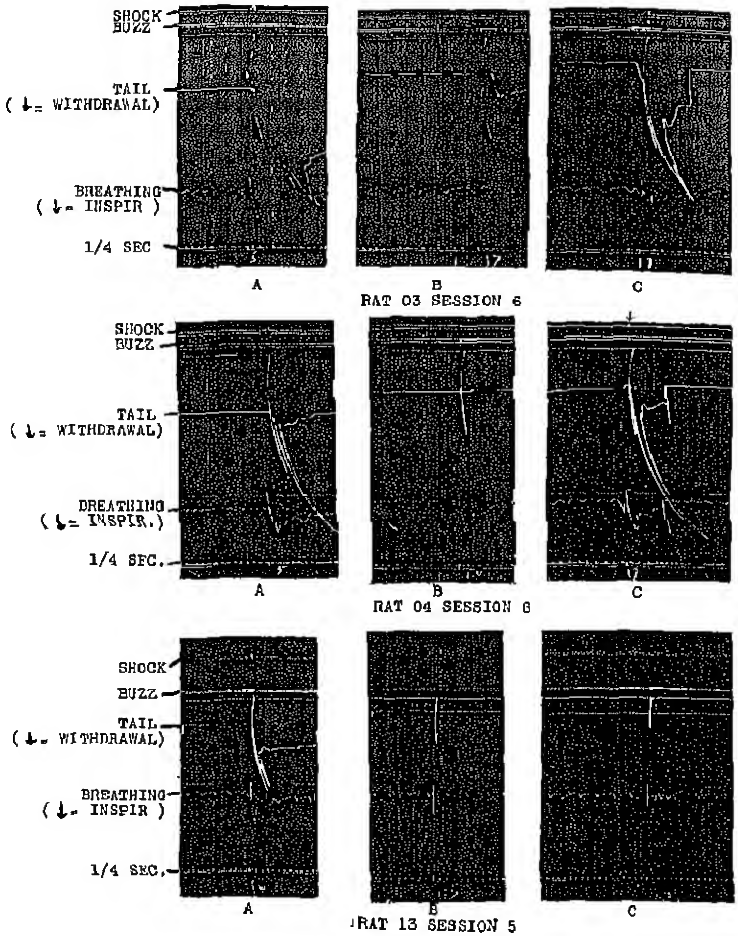

FIGURE 2

Rats 03, 04

A—Responses to isolated shock

B—Conditioned responses to buzz

C—Responses to buzz-shock, showing "early" conditioned responses

Rat 13:

A—Response to buzz-shock

B—Response to light (indifferent stimulus)

C—Conditioned shift in breathing rate, in response to buzz

Note: Simultaneous ordinates have been added, coincident with the shock, if present; otherwise, with the beginning of the buzz or light.

movements were recorded on the breathing curve, as mentioned above. This was particularly true of a forward and upward thrust of the body, caused by extension of the hind legs. It must be stressed that we are really dealing with a unified response, and that it is, perhaps, only on conceptual grounds that one can separate breathing movements from other components of this pattern.

During the training, responses to buzz or light could be observed under two conditions. When the shock was omitted, on "tests," the whole response to the conditioned stimulus could be seen. When the shock was not omitted, one could usually observe the early phases of this response in the interval between buzz and shock As the writer has shown in a previous paper (19), neither method of observation is ideal, but taken together, they become quite satisfactory. The first response to appear as a result of training is usually a shift from slow to rapid breathing This, as mentioned above, sometimes appeared as a response to the new stimulus before training, but it became much more regular after several double stimulations. When the shock was omitted, the rapid breathing lasted from 2 to 10 or 20 cycles (Figure 2, Rat 13, C). When the shock followed the conditioned stimulus, only the early stages of this response could be observed (Rat 13, A). There might be one or two rapid breaths before the shock, or only part of one A very short part of a cycle stood out rather clearly against the background of slow rhythmical breathing usually maintained between pairs of stimuli This shift to smooth rapid breathing is probably similar to the results obtained by Upton (24, 25), Wever (28), and Horton (3). As Wever suggested, this shift is not a typical conditioned response, for it does not resemble the sharp response to shock. The phenomenon is apparently similar to those described under the head of "attention" in man. This response was observed in all animals.

Although the slow breathing described above was usually maintained during the interval between successive stimulations, the rapid form was by no means exceptional Practically all of the rats maintained rapid breathing for the first few minutes of each session, and several showed it irregularly throughout the experiment Under these conditions the shift caused by stimulation usually showed as an increased amplitude of breathing or as a change in level

Under optimal conditions it was possible to obtain a more typical conditioned breathing reaction (Figure 2, Rat 04, B). This consisted of a sharp, sustained inspiration, first appearing within a second or two after the conditioned stimulus After further training this response usually appeared quite consistently between 100 and 300 sigma after the conditioned stimulus. It could thus be observed as an early response, even when the shock followed the buzz or light (Figure 2, Rat 04, C) This response was not as sharp or strong as the response to shock. One or more squeals were often associated with this breathing reaction and were considered to indicate an advanced stage of conditioning.

Conditioned tail withdrawals were another indication of advanced conditioning (Rat 03, B and C) They were less frequent than conditioned inspiratory movements, occurring about as often as conditioned squeals In size they varied from a mere ripple to a sharp, maintained pull, lasting for about a second, and reaching about half the amplitude of the response to shock With some animals a reversed response was obtained, the tail relaxing in response to the conditioned stimulus, instead of being withdrawn (Rat 04, B and C). Comparable phenomena have been observed by the writer (19), and by Shipley (22), with the knee jerk and plantar reflex respectively. Finally, certain tail movements showed on the records as a ripple, rather than as a clear relaxation or pull. All these tail responses were observed as early responses, preceding that to the shock, as well as in their complete form, when the shock was omitted

The development of conditioning may be described in terms of the responses mentioned above It must be remembered, however, that these responses are part of a uniform pattern of behavior, gradually developed At first the rat may occasionally respond to the conditioned stimulus by a shift in the breathing rate After some training the shift becomes a regular occurrence If the conditions are satisfactory, we may find the sharp inspiration displacing the rapid breathing Next slight tail withdrawals and weak squeals appear, and finally the rat regularly takes a deep breath, pulls up his tail, and squeals in response to the conditioned stimulus. The frequency and completeness of this response may be used as a rough measure of the depth of conditioning Such a measure is quite adequate for present purposes, as may be seen from its use in Figure 3. Further

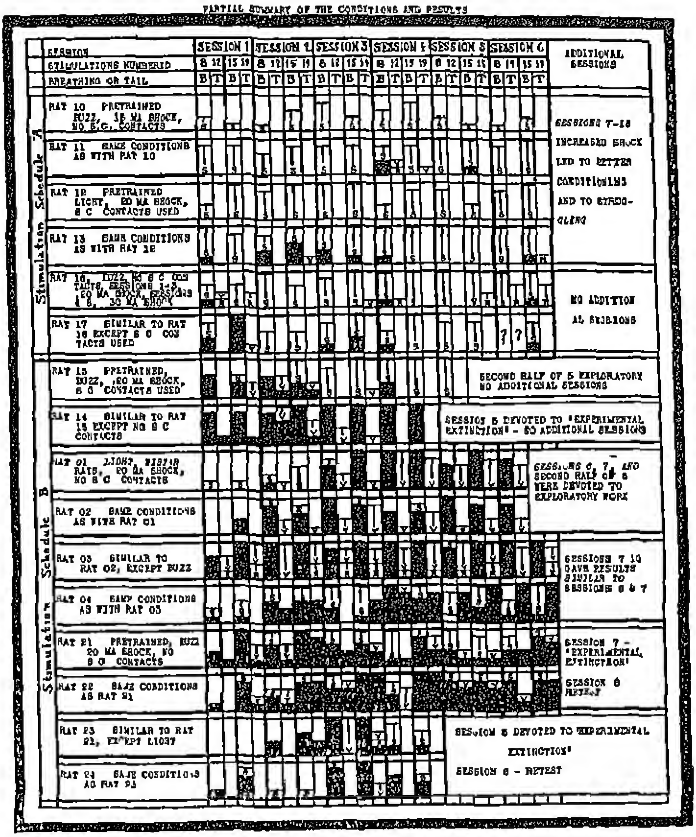

FIGURE 3

The height of the filling in each of the vertical oblongs represents the proportion of "early" responses occurring during that particular group of five paired stimulations. Solid fillings represent typical conditioned responses, as "inspirations" and "tail pulls" under T. Line fillings indicate responses differing markedly from the unconditioned ones, and are explained by letter as follows

S—Speeded breathing
R—Relaxation of tail
V—Vibratory ripple of tail

The progress of conditioning for each rat may be followed by reading across the chart, as though it were a series of learning curves. The abbreviations in the left-hand column refer to the conditions under which each rat was trained and will be understood from the text.

quantification of the results seems to the writer to be inadvisable at present, for it would involve some rather complex questions of weighting, measuring scales, etc. The experimental conditions can, and will be, stated precisely But to state the height of a given response in millimeters would be even more misleading than are Pavlov's tables of drops of saliva.

The Development of a Satisfactory Technique

The general method described above might well be expected to lead to conditioning However, presentation of the paired stimuli does not always lead to the development of a clear-cut conditioned response. Indeed, the prodigious work of the Russian experimenters might almost be summarized as an attempt to formulate necessary qualifications to be added to the first simple law of conditioning But because of the somewhat theoretical nature of most of the material accessible to one who does not read Russian, it is difficult to differentiate between the significant factors in the techniques used and those that are due to tradition [4] It is still more difficult to decide whether a given element is a function of the specific organism and unconditioned reflex used, or of conditioning in general Thus, when one wishes to establish a particular conditioned response in a particular animal, it is first necessary to develop a satisfactory technique. If any consistent progress is to be made in our knowledge of the conditioned response, it seems to the writer that techniques, based upon observed effects of varying the elements, must be devised The following sections describe the development of a technique that satisfies these requirements in regard to some, but not all, factors involved.

Preliminary Experiments

During the spring and summer of 1933, experiments were performed with 24 male albino rats. The purpose of these experiments was purely exploratory, and conditions were deliberately varied as much as possible, in an attempt to discover conditions favorable to conditioning The exploratory work took the form of a number of consecutive experiments, each one involving two or four rats, given from 2 to 10 experimental sessions Each successive experiment was

[4]Razran's reviews (14, 15, 16, 17) are particularly valuable in that they furnish details of the actual experiments.

performed after a careful analysis of the results obtained from the preceding one, and was planned to investigate the effect of varying certain conditions The individual results obtained in these preliminary experiments will not be presented In addition to suggestions for further research, one very important point was clearly established by these experiments—namely, the effect of the number of double stimulations given to the rat during one experimental period

1. *Distribution of Practice* The first 12 rats used were given 200 double stimulations in a single session. Each session was a half hour in length, except with two rats, whose sessions lasted for two hours each. No one of these rats progressed beyond the stage indicated by a shift in the rate of breathing in response to the conditioned stimulus. But when the number of double stimulations during a single session was decreased to about 25, fairly complete conditioning was obtained in 9 out of 10 animals As a further test of the effect of the distribution of practice, 2 animals were given sessions alternating between 200 and 25 double stimulations per period. With these animals the conditioning was clearly established during the "slow" sessions and destroyed during the "fast" ones

Whether this diminished effectiveness of the double stimulations when too many are given during an experimental period is a function of the interval between successive pairs of stimuli, or of the total number of such pairs, cannot be stated with assurance Both factors may well be involved It may be safely concluded, however, that in the present situation more rapid conditioning is obtained if relatively few double stimulations are given during each experimental period The importance of this conclusion may well extend beyond the present problem. When one is studying a quick response, with semi-automatic apparatus, there is a strong temptation to give a large number of stimulations during a short period Among others, the writer has done this in other experiments (*18*, *19*). The Russian workers usually do not give more than 40 or 60 double stimulations during a single period (15, 16), but the writer has seen no statements giving the reasons for this limitation. A more intensive study of this factor, not only in the present situation, but in others, and with other animals, would be well worth while

Main Experiments

Based on the results of the preliminary experiments, a stimulation schedule was prepared for the main experimental animals. This schedule was not the best possible one from the standpoint of rapid conditioning, but was designed to furnish a framework for the desired observations. Two slightly different forms were used Form A is shown in Table 1 Form B had two double stimulations substituted for two "test" presentations, as noted on the schedule shown. Comparable forms were prepared for the animals to be conditioned

TABLE 1
Stimulation Schedule
Form A

Rat		Session	Description			
Date		Hour	Shock			
No	**Time**	**Stim**	**Given**	**Breathing**	**Squeal**	**Tail**
1	0 00	B				
2	1 00	L				
3	2 10	L				
4	3 00	B				
5	3 45	S				
6	5 10	B				
7	6 00	L				
8	7 00	BS				
9	7 30	BS				
10	9 00	BS				
11	10 00	BS				
12	10 45	BS				
13	11 45	B				
14	12 30	L				
15	14 00	BS				
16	14.45	BS	Form B			
17	16 15	BS	changed			
18	17·00	BS	as below			
19	17.30	BS				
20	19·00	B				
21	20·10	B	L			
22	21·00	B	BS			
23	21 45	L	BS			
24	23 00	BS				
25	24 30	BS				

"B" indicates Buzz
"L" indicates Light
"S" indicates Shock
"BS" indicates Buzz followed by Shock

to the light, instead of the buzz These schedules were followed with the aid of a stop-watch during each session It will be noted that blank spaces were left on these schedules for the notation of the responses made to each stimulation. The column headed "Squeal" was filled in during the experimental period, and those labelled "Breathing" and "Tail" after an examination of the kymograph records Thus the slip, when filled out, furnishes a convenient record of each session for each animal.

Using this schedule, 16 animals were given from 5 to 13 sessions each The animals were healthy males, 4 to 8 months old, and were taken from the laboratory colony All of them were of somewhat remote Wistar stock, with the exception of Rats 01-04, which had been obtained directly from Wistar Institute, and used previously for breeding purposes

The chart (Figure 3) presents a graphic record of the development of certain aspects of conditioning in each rat of the main group, together with a summary of certain significant variations in the procedure Early breathing and tail responses observed during double stimulation are represented, rather than full responses to the conditioned stimulus alone The former method gives a more stable measure of conditioning than the latter, for it is based on a larger number of stimulations Either method would measure the same thing, for the response to the conditioned stimulus almost invariably starts within 200 sigma, so that only the later phases of this response can be modified by the presence or absence of the shock Squeals are omitted by the method adopted, because they were never observed as early responses. This naturally follows from the fact that the rat does not squeal during an inspiration Squeals usually occurred with about the same frequency as tail withdrawals, but rats differed somewhat in this respect.

The chart was prepared after the experiments were completed, directly from the kymograph records, rather than from the summarizing slips. This method was chosen to assure uniform interpretation The responses usually fell clearly in one of the categories described above Occasionally, however, there was some question as to whether an early break in the breathing curve should be interpreted as the beginning of rapid breathing, or of a sharp inspiration. Similar questions also arose in connection with the description of small tail movements In such cases decisions were

made after an examination of the total response made by that rat on the next "test" presentation of the unconditioned stimulus. Where two or more responses in one sequence were clearly intermediate, they were divided between the two categories involved.

1. *The Strength of the Shock.* Ideally the strength of the shock would be described in terms of the density of the current passing through the receptive elements of the stimulated member. In most actual situations such a description is impracticable A number of alternatives present themselves, each having certain advantages and disadvantages.

Perhaps the most convincing criterion of the strength of the shock is the response it elicits in the organism. This criterion is particularly valuable when we are studying conditioning, for obviously one wishes to obtain a *response* to conditioning to new stimuli. It must be clearly realized, however, that we are not directly describing the unconditioned stimulus when we use this method In addition to possible variability of the threshold of the receptive elements, there is almost certainly a variation in the general reactivity to shock. Thus the response to a given stimulus will vary from time to time and from rat to rat, depending upon certain general factors such as past experience with shocks, present emotional state, etc. In the preliminary experiments this criterion was generally used. It was found that shock strong enough to call out a vigorous inspiration, tail withdrawal, and squeal was necessary for conditioning. On the other hand, too strong a shock causes persistent struggling, and prevents further experimentation

One may also describe the shock in terms of certain constants in the stimulating circuit, such as amperes, volts, ohms, and seconds. In the present experiments, these constants were known When the rat is placed between the electrodes, one must also consider total tissue resistance, area of electrodes, and distribution of current through the tissue. In the present experiments total tissue resistance can be neglected, because of the high external resistances in the stimulating circuit. Electrode area was fairly constant, varying slightly with the circumference of the tail But the path taken by the current, flowing from electrode to electrode, could not be controlled. The distribution of current would be a function of the relative resistance and amount of skin, fat, muscle, and bone in the tail. The most variable one of these factors seems to have been

relative skin resistance In moist, damp weather the strength of the current had to be increased to two or three times its usual value. It is likely that a large part of the current was flowing along the surface of the moist skin, thus failing to pass through the receptive elements The possibility of additional leakage across the moist surfaces of the hard rubber bases of switches, keys, etc., cannot be completely ruled out If such leakage occurred, it must have been very slight, for the meter returned to zero when the electrodes were "open."

The effects of moisture were troublesome only during the preliminary experiments The main experiments were conducted while the central heating plant was in operation, and the atmosphere of the laboratory was extremely dry. Therefore the strength of the stimulating current (given in milliamperes in Figure 3) may be considered as the significant variable in determining the strength of the unconditioned stimulus, if we confine ourselves to those rats with which the short-circuiting contacts were not used. When the short-circuiting contacts are used, the duration of the shock is decreased, necessitating a 1/3 increase in its intensity, if comparable reactions are to be obtained. An examination of the chart will show that a current of 2 milliamperes (duration, 165 sigma) is strong enough to give satisfactory conditioning It also seems probable that one of 15 milliamperes is less favorable to the development *of conditioned responses*

Some combination of these two methods of describing the shock may ultimately be found satisfactory For example, the stimulating current might be stated as some multiple of the threshold value. A few measurements made on rats with the present apparatus suggest that the threshold stimulus for tail withdrawal is in the neighborhood of 05 milliamperes, but no consistent attempt has been made to develop the method further. For present purposes it seems best to relate the development of conditioning directly to the strength of the unconditioned response, rather than to analyze this factor further.

The general conclusion to this section will therefore be stated in terms of the strength of the unconditioned response. The rapidity and strength of the conditioning is dependent upon the strength of the response *to the shock used during training A shock eliciting* a weak response is unfavorable to the development of conditioning,

and one causing continued struggling makes further study impossible. Additional evidence for this conclusion may be obtained from a careful study of the records of individual rats Since the conclusion is consistent with other findings, it seems unnecessary to record this evidence here

2. *The Effect of the Short-Circuiting Contact* In various experiments utilizing shock as the unconditioned stimulus, two fundamentally different methods of administering the shock have been utilized The first method involves the presentation of a shock of predetermined duration, regardless of the response made to the conditioned stimulus. In the second method the animal is arranged so that its response will either prevent or terminate the shock Both methods have been used extensively, apparently without any suggestion that they may be fundamentally different The first method seems to the writer to be more nearly similar to that utilized in experiments using other unconditioned stimuli Hull (4) has discussed a "dilemma" that arises when the second method is used, particularly in connection with certain practical learning problems. He does not consider the first method, which is, perhaps, less typical of actual situations but more typical of the laboratory conditioned response situation.

In the main group, the first 8 rats were divided between the two methods Rats 10, 11, 16, and 14 were always stimulated by a shock of 165-sigma duration Rats 12, 13, 15, and 17 were attached to the short-circuiting contacts described above, so that the first millimeter of tail withdrawal would terminate or prevent the shock, and keep it "shorted" until a movement in the reverse direction started There is no significant difference between the results obtained from animals that actually shortened the duration of the shock by every response made to it, and those that were always given a shock of predetermined duration. This result was very surprising to the writer. It was obtained consistently in the preliminary experiments as well as in those of the main group. The explanation must await further experimentation It is possible that there are certain differences in conditioning established by the two different methods that have not been detected in the present experiments. The lack of gross differences may be a function of some particular aspect of the technique used, such as the temporal characteristics of the stimulus sequence. In view of the great import-

ance of this question in general learning theory, it seems advisable to investigate the rôle of the response in other simple situations

3 *The Conditioned Stimulus* Rats 12, 13, 01, 02, 23, and 24 were trained with the light already described as a conditioned stimulus, while the others were conditioned to the buzz By comparing the results obtained from the light-positive rats, as indicated in the chart, with those obtained from buzz-positive rats, trained under comparable conditions, it may be seen that the buzz is a more effective conditioned stimulus than the light These statements apply, of course, only to the particular stimuli used in the present experiments, described under the section on "Apparatus" Other evidence corroborates the view that the buzz is the more effective conditioned stimulus The stimulation schedule permitted the presentation of "indifferent" stimuli during the conditioning sessions Thus, with the light-positive animals, a buzz was occasionally presented, but never reinforced The light was similarly presented to the buzz-positive animals The animals trained to react to the light frequently made a complete conditioned response (inspiration, squeal, and tail withdrawal) to the buzz, as well as to the light The response of these animals to the buzz was often weaker than that to the light, but it was clear. Much less "spread" was shown by the buzz-positive animals, although they occasionally gave a weak or partial response to the supposedly "indifferent" light, especially during the early sessions.

The greater effectiveness of the buzz as a conditioned stimulus is probably related to some more generalized effectiveness Thus the buzz used in the present experiment frequently caused a break in the breathing rhythm, even before training The light rarely did this, even though it caused a rather marked change in the illumination of the rat's eye. Such differences as the ones noted above certainly cannot be carried over directly to other animals, or even to rats with pigmented eyes, but must actually be determined for the animal under consideration. The greater effectiveness of the buzz was very clear, however, in the present experiments

4 *"Test" Presentations* Ever since Pavlov described the phenomenon referred to as "experimental extinction," it has been clear that "test" presentations of the conditioned stimulus, unreinforced by the unconditioned one, are apt to delay the development of conditioned responses. A certain number of test presentations are neces-

sary, however, if any description of the actual conditioned response is to be obtained. Form A of the stimulation schedule (see Table 1) called for the presentation of 7 such tests, while Form B involved 5. The difference between the two schedules is probably greater than the total number of tests would indicate, for 3 of these tests were presented at the beginning of each session, before any double stimulations were given Thus any inhibiting effects these three tests may have had were probably isolated to the early part of each session The more significant "tests," therefore, may well have been those made during the main part of the session, numbering 4 and 2, respectively, in the two forms

A glance at the chart will show that the first 6 rats of the main group, trained under schedule A, conditioned much less completely than did the remaining 10, trained under schedule B Whether a further decrease in the number of tests would result in still better conditioning cannot, of course, be determined from the results Schedule B could probably be improved somewhat by the use of several double stimulations during the first 7 presentations

5. *Struggling, Excitement, Pretraining, and Individual Differences.* The rats generally struggled somewhat the first few times they were placed in the holder In the preliminary experiments it was often found that this struggling obscured the observation of the development of conditioning during the first few sessions. Stimuli could be presented, even during the most violent struggles, but it hardly seemed advisable to do so To eliminate this struggling, the animals of the main experiments were generally "pretrained" by several half-hour periods of restraint in duplicate holders. This expedient was quite successful, although the rats still had occasional periods of excited struggling

Rats differed a great deal in this respect, however. Rats 01-04, of different stock from the others, were very much more quiet, and did not need the pretraining. These differences in what may be considered emotional characteristics of the rats probably played an important part in determining individual differences in the speed and characteristics of conditioning. Throughout the experiments it was observed that the most "excitable" rats conditioned most readily Indeed, one might describe the condition of excitement as one of great spread or "irradiation" in which any stimulus, conditioned or otherwise, would call out a generalized response

Thus pretraining, while clearing up certain difficulties resulting from struggling, probably retarded conditioning The question of the relationship between excitement and rate of conditioning merits further research (19) Certain poorly controlled observations have been made on the effects of excitement induced by alcohol vapor or tobacco smoke, but no conclusions will be presented. The writer hopes to investigate this question with properly controlled doses of excitement-inducing drugs For such an experiment, and for many others suggested by the present investigation, it would be very advantageous to have a stabilized strain of rats Indeed, one of the greatest difficulties encountered during the present experiments was the variability of the rats. It may eventually be necessary to classify rats under different "types," as Pavlov has done with dogs

The differences between rats are shown clearly in the results obtained from rats 03 and 04. These rats were brothers, and were run under substantially the same conditions (see chart, Figure 3, and Figure 2) Each session devoted to rat 03 was duplicated, stimulus for stimulus, with rat 04, forty minutes later But their behavior was markedly different Rat 03 was generally quiet, breathing slowly and regularly When stimulated by a shock, it reacted sharply, gave a single short squeal, and then returned to the slow breathing On the other hand, Rat 04 struggled frequently, and usually breathed rapidly When stimulated by a shock this rat gave a very strong reaction, several loud squeals, and did not return to regular breathing until several seconds had elapsed. The conditioned response developed by these rats likewise differed Rat 03 regularly showed a sharp tail pull in response to the conditioned stimulus, accompanied by rapid, irregular breathing, but no squeal. Rat 04, however, usually showed a tail relaxation, sharp inspiration, and several squeals in response to the conditioned stimulus.

The writer does not suggest that these differences are fortuitous, but rather that they cannot be controlled at present It seems probable that these differences between rats could be minimized by the use of rats of uniform genetic characteristics that had been reared under constant conditions Until this has been done, these variations will probably continue to be troublesome

General Results

1 *"Frequency"* The foregoing discussion has attempted to describe the results obtained from repeated presentation of paired stimuli In view of the importance of these factors, it seems useless to average the results indicated in each vertical column of the chart and thus set up some general law in regard to the effects of "frequency" It is more important to emphasize the fact that repetitions of stimulus sequences under definite conditions merely permit accumulation of the effects of each sequence. To the extent that these effects are positive, conditioned responses will increase with repetition roughly in the order described under "Responses" In the present experiments there are clearly both positive and negative factors Their interaction, as double stimulation is repeated, results in the variations in response that are so evident in the chart.

2 *Experimental Extinction* It is often stated that "frequency" has a negative effect during experimental extinction If we follow the method used in the preceding section, we will say, rather, that a single unreinforced presentation of the conditioned stimulus weakens the conditioned response, and that repetitions of unreinforced stimulation permit summation of this effect Under the discussion of the effect of test presentations of the conditioned stimulus, it was shown that such unreinforced stimulations retarded the development of conditioning With several of the animals of the preliminary experiments, and with 5 animals of the main group, repeated unreinforced presentations of the conditioned stimulus were made, in an attempt to study experimental extinction This was done after the animals had been subjected to the usual training period (see Figure 3). The individual records cannot readily be reduced to tabular form, because the stimulation schedule used for each rat depended largely upon the progress of extinction in that particular rat Session 7 of Rat 22 will illustrate many of the phenomena observed during experimental extinction, and will be described

The first stimulation of the session, a buzz, resulted in a slight shift in the level of breathing. Following the usual stimulation schedule, two lights were presented, and then another buzz This buzz, and the three following, elicited sharp inspirations and tail withdrawals, but no squeals. The fifth and sixth buzzes resulted only

in fast breathing The animal was then stimulated with a light-shock sequence (Buzz-shock had been intended, but the shock has reinforcing value, even without the buzz, as will be shown below) The next two buzzes were followed by squeals, in addition to inspirations and tail withdrawals The squeal dropped out on the next buzz, but inspirations and tail withdrawals continued, undiminished in amplitude, through 16 unreinforced presentations of the buzz These stimulations had been separated from each other by intervals ranging between 15 seconds and 2 minutes When the interval was decreased to 5 seconds, the conditioned responses rapidly dropped off, only a shift in rate of breathing appearing in response to the second and third rapid presentation of the buzz After a rest of one minute, however, both inspiration and tail withdrawal reappeared with undiminished vigor. The experiment was then discontinued

The record of this animal, although better than some, is not extreme One of the rats used in the preliminary experiments continued to respond to the conditioning stimulus with inspiration, tail withdrawal, and squeal, through 25 unreinforced presentations On the other hand, animals that have been less thoroughly conditioned may show complete extinction after a few "tests" It will be recalled that too many "tests" during the first few sessions seemed to retard conditioning

In summarizing this section, it may be stated that unreinforced presentations of the conditioned stimulus weaken the conditioned response The amount of such weakening seems to depend upon the depth of conditioning, and upon the interval between unreinforced stimulations.

3 *Isolated Shock.* In the summary of the case of experimental extinction described above, it will be noted that a single light-shock stimulation had marked reinforcing value The animal had been conditioned to a buzz, and even after this accidental combination of light and shock, showed very little response to the light alone The reinforcing effect was, therefore, chiefly effective on the response to the buzz, and must have been caused largely by the shock. Pavlov (13, p 59) has mentioned the reinforcing effect of the unconditioned stimulus, even when presented alone The writer has seen no other reference to this phenomenon, although it has been observed quite regularly during the present experiments

During the preliminary experiments it was repeatedly observed that the isolated presentation of the unconditioned stimulus would greatly reinforce a conditioned response weakened through extinction or disuse. In the main experiments a single shock was presented as the fifth stimulus, preceded and followed by "test" presentations of conditioned and "indifferent" stimuli By comparing the responses to stimuli presented before and after the shock, it was possible to observe the reinforcing effects of the isolated shock The reinforcing effect only occurs if some conditioning has actually been established in a previous session In such cases the shock causes a marked increase in the response to the next "test" stimulus, but does not seem to have as great a reinforcing effect as the more usual double stimulation Single presentations of the shock do have a reinforcing effect that could not be duplicated by other strong stimuli, such as the explosion of a percussion cap, sharp tapping on the table, or even violent shaking of the rat's holder.

4. *Freedom from Stimulation.* The conditioned responses fell off considerably during the intervals between sessions. During these intervals the environment of the animals was quite free from "buzzes" but not from changes in illumination. Usually the interval between successive sessions was 24 hours Occasionally intervals of several days, or even two months, were deliberately introduced between sessions (the records of such sessions are *not* included in the chart). In general, there was a moderate loss during the shorter interval It was hoped to quantify this loss by the presentation of two conditioned and two "indifferent" stimuli at the beginning of each session. The loss during 24 hours, when determined by comparing the responses made to the first two test stimuli with those made near the end of the preceding session, seems to be enormous Other evidence, such as the comparison between early responses elicited by stimulus sequences 8-12, and 15-19 (see the chart), suggests a more moderate loss. Further, when experimental extinction was attempted at the beginning of a session, the first few conditioned stimuli produced little, if any, response. This was not true if the extinction was started later in the session It seems likely, then, that the relative ineffectiveness of the first few conditioned stimuli is not a measure of the effect of the 24-hour interval between trials, but is caused either by an inhibiting effect of the massed "tests," or by some "warming-up" effect

Although the loss during an interval of 24 hours, or even of several days, was found to be moderate, that occurring over 2 months of no training was very pronounced In fact, the behavior of several rats, retested 2 months after training had been discontinued, could not be clearly differentiated from that of untrained rats. Fine differences may have existed, but the present technique did not detect them

5 *Controls.* In spite of the "spread" mentioned above, there can be no doubt that responses were conditioned to the buzz and light. The first possible source of error might have been leakage of current through the short-circuiting switch. To minimize this possibility, .5 megohms of resistance were always left in series with the electrodes, so that any slight leakage would have had little effect on the rat. To check the question by test, the conditioned stimuli were occasionally presented with the electrodes removed from the tail. No difference was ever observed under these conditions. Extraneous "cues" might have been of two sorts, those involved in the presentation of the stimulus, and incidental ones. The latter are readily eliminated because of the precise temporal relationships that exist between the conditioned stimuli and responses The sound of the kymograph, shadows cast by the experimenter, etc, might occasionally call out a response at about the right time, but precise coincidence would be rare. As mentioned above, all such stimuli were eliminated as much as possible, and caused very little trouble. The kymograph was quiet, and was operated for various durations before the presentation of stimuli The front end of the holder was covered, to eliminate visual cues. Finally, the room was rather free from extraneous sounds. The possibility that secondary cues were involved in the actual presentation of the stimuli is a more serious one. Markers and keys were silenced as much as possible. As a check on the effectiveness of these methods, control tests were frequently given For the buzz-positive animals, the presentation of the light served as a fairly adequate check, for exactly the same movements were made by the experimenter as would have been made in presenting the buzz The only difference in the situation was that a switch had been thrown at least a minute before the stimulation Still more convincing tests were furnished occasionally when the experimenter accidentally left a switch open, thus failing to sound the buzz when he expected to do so In no

case did the rat react With the light-positive animals, control tests were made after shutting off the lamp with a rheostat. This left the routine of operations and movement of markers unchanged In the case of one animal it was found that the faint click of the "light" marker would call out the response After the marker had been readjusted, the difficulty disappeared. No other animal showed a response when the light had been turned off. The incident mentioned above, however, shows the value of a sound-resisting box when relatively ineffective stimuli are being used It also shows that the rat can be conditioned to very weak sounds But the control tests show clearly that the responses have been conditioned to the intended stimuli

This statement should not be interpreted to mean that other stimuli, such as those caused by contact with the holder, etc, were not related to the response. It is quite possible that the conditioned response would have been disturbed if these relatively constant stimuli had been changed. As in all conditioning studies, it must be clearly understood that the response is a function of the conditioned stimulus when other factors are held relatively constant.

6 *Discussion.* The results of this experiment may be considered from three aspects, namely, the development of a conditioning technique for the rat, the description of the behavior observed in a conditioning situation, and finally, the applications to a general theory of learning. Under the first heading, it will be recalled that roughly similar techniques have been utilized by Upton (24, 25), Wever (28), Horton (3), and Newhall and Sears (12) In the present study, somewhat more detailed attention has been devoted to the effects of various factors in the technique itself than was true of the experiments mentioned above In this experiment the fundamental interest was in the conditioning, whereas in the others mentioned it was in the sensitivity of the animal The method described in this paper should be quite satisfactory for threshold studies It would not, of course, be necessary to establish a complete conditioned response for such purposes since the earliest modifications of the breathing curve would indicate stimulation. The technique described is probably not optimal—indeed, a study in progress in our laboratory[5] suggests that conditioning is

[5]This experiment, carried out by Mr W R Pfouts in conjunction with the present writer, utilizes the same general technique as the present

somewhat easier if a foot is stimulated instead of the tail Additional modifications in the technique for specific purposes may be advisable It will be recalled that some modifications have been suggested during the discussion of the specific results

In regard to the second aspect, little need be added here The description of the results has been made as complete as limitations of space permit. It seems advisable, however, to caution the reader against interpreting these results *in* too abstract a *fashion*. They are descriptions of, and generalizations from, an extremely variable mass of behavior, even though they were obtained under precisely determined conditions They have been phrased in conditioned response terminology because such a system of description seems to fit them best It is quite possible that some entirely different system might have been developed that would have fitted them better, but the writer does not feel inclined to develop another system Every effort has been made to avoid description in terms either of a hypothetical physiology, or of an anthropomorphic system based upon concealed indirect introspection

Finally, the results described here do not seem to the writer to encourage the continued construction of general learning theories with the conditioned response as a basis They do show that it is possible to establish conditioned responses roughly resembling the unconditioned ones. But they also show that the development of such responses is retarded or prevented if a number of factors vary beyond rather narrow limits Before any case of learning can be described as a complex of conditioned responses, it must be demonstrated that the conditions fall within the limits described It seems unlikely that this can be done in the vast majority of cases in which learning occurs. It appears to the writer to be more probable that the conditioned response, as experimentally observed, is only one type of learning, no simpler than the other types traditionally considered under the headings of "trial and error," "association," etc (The reader may substitute the word "aspect" for "type," if he prefers) Each type is worth studying, both for its own sake and for the light it sheds on the others, but probably no one of them is more fundamental than the others The writer knows of no ex-

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experiments The detailed results will be described at a later date, but it may be mentioned in passing that they are very similar to those obtained in the present paper

perimental study of the conditioned response that yielded results inconsistent with this view[6]

Summary

1. When a buzz or light is repeatedly presented to a rat for 335 sigma, and then accompanied by a shock to the tail for an additional 165 sigma, conditioned breathing, tail movements, and a squeal are obtained.

2. These responses are described. They generally develop in the order given above, and may be taken as a measure of "depth" of conditioning.

3. A satisfactory technique for establishing these responses has been developed Certain important factors in this technique are.

a Two hundred paired stimulations during each session prevent conditioning Fifteen or twenty is a more favorable number.

b A shock strong enough to elicit a vigorous response is advisable A weaker one retards conditioning, while a stronger one causes struggling.

c It makes no great difference whether the rat terminates or prevents the shock by its response, or whether, on the contrary, the duration of the shock is held constant

d Not more than two or three unreinforced ("test") presentations of the conditioned stimulus are advisable during each session

e The buzz used is a more effective conditioning stimulus than the light

f. "Pretraining" the rat decreases struggling. It may, however, retard conditioning by preventing "excitement" This problem is complicated by "individual differences" between rats

4 The effects of repetition depend upon the effects of the stimuli repeated These effects are·

a In the present experiment, each paired stimulation apparently involves factors both favorable and unfavorable to conditioning The effects of "frequency" will depend upon the summation of these factors.

b. Unreenforced presentation of the conditioned stimulus weakens the conditioned response This is particularly important

[6] A complete discussion of the arguments for and against the conditioned response theory of learning is beyond the scope of this paper.

during training. The fully developed conditioned response is quite resistant to experimental extinction.

c A shock, unaccompanied by the conditioned stimulus, has a marked reenforcing value.

5. There is a moderate loss in the strength of the conditioned response between sessions separated by one day. During a two-month interval the response is practically lost

6. Control experiments show that the conditioned responses described were elicited by the conditioned stimuli, rather than by extraneous "cues"

7. It seems probable that the conditioned response is only one of a number of types of learning, rather than the fundamental basis of all learning

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LES RÉPONSES CONDITIONNELLES CHEZ LE RAT BLANC

(Résumé)

On a présenté à plusieurs reprises un son bourdonnant ou une lumière à des rats blancs pendant 335 σ, et ensuite on a fait accompagner le son ou la lumière par un choc á la queue pendant 165 autres σ La première modification qui s'est montrée a éte un changement du rythme de la respiration Plus tard, des réponses conditionnelles plus typiques se sont montrées quelquefois, telles qu'une inspiration brusque, et, enfin, l'action de retirer la queue et des cris Nombre de facteurs ont été importants dans la déter-

mination de la vitesse et de la profondeur du conditionnement Entre autres, ceux-ci ont compris la force du choc, le stimulus conditionnel employé, le nombre de stimuli mis en paires pendant chaque période, la fréquence des tests, et la condition de l'animal Très peu de différence s'est montrée quand le rat a pu terminer le choc par sa réponse On a étudié aussi les effets de l'extinction expérimentale et ceux de la présentation isolée du choc, ainsi que ceux de la stimulation plus usuelle en paires Une réponse conditionnelle bien établie résiste beaucoup à l'extinction expérimentale, mais perd beaucoup de sa force d'un jour à l'autre La complexité du comportement, et la grande dépendance des valeurs optima pour certains facteurs le rend probable que le réponse conditionnelle n'est qu'une forme de l'apprentissage, plutôt que la base fondamentale de tout l'apprentissage

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BEDINGTE REAKTIONEN BEI DER WEISSEN RATTE

(Referat)

Ein Laut oder ein Licht wurde weissen Ratten fur 335 σ wiederholt dargeboten, worauf der Reiz von einem elektrischen Schlag auf den Schwanz fur noch 165 σ begleitet wurde. Die erste Veranderung, die erschien, war ein Wechsel des Atmenrhythmus Spater kamen manchmal typische bedingte Reaktionen vor, wie eine scharfe Einatmung, und schliesslich die Zuruckziehung des Schwanzes und das Quieken Eine Anzahl Faktoren waren wichtig zur Feststellung der Schnelligkeit und Tiefe des Bedigens Unter anderm waren diese die Starke des Schlages, der angewandte bedingte Reiz, die Zahl der gepaarten Reize wahrend jedes Versuches, die Haufigkeit der Tests, und der Zustand des Tieres Es schien wenig Unterschied zu machen, ob die Ratte den Schlag durch ihre Reaktion beenden konnte oder nicht Die Wirkung der experimentellen Ausschaltung und die isolierte *Darbietung des Schlages* sowie die gebrauchlichere gepaarte Reizung waren auch untersucht Eine gut befestigte bedingte Reaktion ist ziemlich widerstandsfahig in bezug auf experimentelle Ausschaltung, aber verliert an Starke ziemlich viel ubernacht Die Verwicklung des Verhaltens und die grosse Abhangigkeit von den gunstigsten Werten fur gewisse Faktoren machen es wahrscheinlich, dass die bedingte Reaktion nur eine Form des Lernens ist, eher als die Hauptbasis fur das ganze Lernen

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VISUAL DISCRIMINATION IN THE CAT: II A FURTHER STUDY OF THE CAPACITY OF THE CAT FOR VISUAL FIGURE DISCRIMINATION*

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KARL U. SMITH

I. INTRODUCTION

In a previously reported experiment (23) seven cats were trained and tested under controlled conditions in the attempt to determine whether or not these animals possessed a capacity for discriminative response to a circle and triangle of equal area exposed against a homogeneous ground. The outcome of this study showed that each of the animals could make the required responses during changes of sensory influences other than those directly related to the significant stimuli. That is, differential olfactory, auditory, tactual, or extraneous visual stimuli which might have been present for the animal could be varied to a great extent without modifying the responses Accordingly, the assumption was made that the visual figures, as presented in the apparatus described, were effective in determining the responses found

In the present study the question is raised as to whether or not, under certain conditions, the responses of the cat to visual figures are determined by some aspect of the "form" of the figures, and if so, what differences exist between such responses and the responses of other species of animals in comparable situations As an approach to this problem and to aid in presenting the results of this study, prior investigations of form discrimination in animals must first be reviewed briefly.

II. SUMMARY OF PREVIOUS EXPERIMENTS ON FORM DISCRIMINATION

The results secured in previous investigations of form discrimination have served mainly as a basis for inferences concerning mechanisms of "conception," "generalization," and "abstraction" in ani-

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mals Fields (5) trained rats to discriminate a circle and triangle in various positions and then modified various aspects of the total situation in numerous check experiments Since his animals continued to respond discriminatively when figures of different color, different area, and different figure-ground characteristics were presented, Fields stated that. "Rats are able to perfect a type of behavior which is fully described by the implications inherent in our use of the term 'concept'." (p. 69)

Revesz (20) required monkeys to respond to visual figures varying both in color and in form, and then introduced variations in color and form in the visual stimuli. Two monkeys could respond discriminatively when identical figures varying in color were presented or when different figures of similar color were exhibited. According to Revesz this seemed to show that the animal's behavior fulfilled "an important preliminary condition for abstractive performance" (p 341)

Tellier (25, 26, 27, 28) has come to conclusions similar to those of Revesz but on the basis of a greater number of experiments. She proposes to consider the monkey's ability to respond to a series of forms in which are produced systematic changes as a capacity for "generalization" Tellier has shown that one monkey (*Macacus sinecus*) would respond tactually to geometric figures which had been learned previously by visual-tactual stimulation and by visual stimulation alone (25, 26). She has also studied the monkey's responses to cards bearing different visual figures, horizontal and vertical lines, different numbers of black dots, pictures of animals and vegetables, and pictures of quadruped and biped animals, as well as by having the animal respond to solid figures

More commonly, however, studies in form discrimination have been related to a question as to the ability of some animals to make specific kinds of "abstractions," viz, to respond to "form *per se*" or to "triangularity *per se*"

Bingham (1, 2) raised the question as to whether or not the chick could respond to "form *per se*" He required chicks to discriminate between a circle and triangle of equal area and then inverted the triangle His subjects would not respond differentially after the position of the triangle had been changed. Bingham wrote in consequence of this experiment that there was no true discrimination of form in the chick, but rather, "The apparent reactions

to form were the result of a keen perception of size differences" due to unequal stimulation of different parts of the retina (2, p 140). He called this size factor "shape" as opposed to "form *per se*." In short, Bingham assumed that inverting the triangle changed the relative size differences (for the animal) between the two figures, the supposition being that the chick responded to only a part of the original training figures and consequently saw more of one than the other Moreover, Bingham (3) found in further experiments, by introducing circles and triangles of different relative size, that relative size differences were significantly involved in the chick's responses to the visual stimuli.

Hunter (8), in a paper appearing soon after Bingham's original experiments (1), held that animals and young children do not respond to form According to this writer the responses of such animals are determined by "crude pattern vision." Munn and Steinung (17), Munn (16), Gellermann (6), and Neet (18) studied what Hunter called pattern in relation to the discrimination of visual figures in different animals. In each of these experiments, after establishing discriminative responses to smaller figures (forms) placed inside larger figures (backgrounds), the form of the latter was changed Since such changes, in general, did not influence the responses, all of these investigators have held that pattern, in the sense that the word is used above, is not significantly involved in the behavior of animals in situations involving form.

The attempt has been, in recent studies of form discrimination, to investigate responses to that which has been defined as "form *per se*" Munn and Steinung (17), after making numerous experiments with a ten-year-old child, came to the conclusion that what is meant by the capacity to abstract "form *per se*" is that "a form can be responded to regardless of its position in space and the background upon which it appears" (p 88). Following this definition, Munn and Steinung held that there was "indubitable proof of a response to 'form *per se*' in the child" (p 87) On the basis of a definition similar to that of Munn and Steinung, Gellermann (6) believed that children and chimpanzees could respond to "form *per se*" Neet (18), after making experiments similar to those of Munn and Steinung and Gellermann, concluded that, of four monkeys studied, one responded to "form *per se*," while the other three responded to "shape." Munn held that chicks (16) and rats (15)

respond to "shape," and Karn and Munn (10) inferred the discrimination of "shape," rather than "form *per se*," in the dog. In all of these experiments, as far as known, the use of the term "shape" has been in accordance with Bingham's original definition, that is, in terms of relative size differences.

Further significance has been added to the theory of the presence of a response to "form *per se*" by Neet's (18) statement that "Such a response may be evidence of the existence of a symbolic process controlling the reaction to triangularity or three-sidedness, without which a response to form *per se* would be impossible" (p 194) Gellermann (6) has also emphasized the importance of a symbolic mechanism in the child's and chimpanzee's discrimination of "form *per se*" Neet (18), in his study, implied that a discrimination of shape required no postulation of a surrogate mechanism for the control of the response. Such an "all-or-none" distinction between a response to "form *per se*" and "shape," therefore, permits clear-cut inferences concerning the presence or absence of psychological mechanisms of "abstraction," "generalization," or "conception" as they may appear at different levels in the animal scale So far, the capacity for abstracting form has been attributed to primates only (14, p 30).

In the above-mentioned experiments a response to "form *per se*" has been inferred depending upon the behavior of a subject when *systematic changes are introduced in the experimental situation, after* a discrimination has been established The variations so far employed in this connection include. (1) rotation of a positive figure through 180 degrees or less; (2) introduction of a blank card or "novel" figure for an original training figure, (3) simultaneous rotation of a positive figure and introduction of a "novel" figure for the negative form, (4) introduction of skeleton, partial, or other "equivalent" figures, (5) reversal of the luminosity values of the two figures and their backgrounds; (6) change in larger forms (backgrounds) but keeping smaller figures (forms) unchanged; (7) alteration of the angular relationships of a figure, (8) change in relative and absolute size of the figures Variations 1-3 inclusive have been taken by Munn and Steinung to give "unequivocal evidence to triangularity, to form *per se*," in the child Neet (18) distinguished between a response to "form *per se*" and response to "shape" on the basis of test 3. Test 2 has been em-

ployed to ascertain whether a response is relative or absolute with respect to either of the two significant stimuli. Test 6 was devised by Munn and Steinung (17) to determine the effectiveness of a background in influencing a response to form, and was suggested by Hunter's emphasis upon "pattern" vision.

If a subject fails to fulfill any of the "behavioral criteria" for response to "form *per se*" it is alleged by these experimenters that the animal responds to "shape" An exception to this statement may be noted. Karn and Munn (10) wrote that since dogs could make a discrimination of "equivalent" figures (for example, the bases of previously learned upright and inverted triangles) the animal possessed only a capacity for "shape" discrimination. In the main, the discrimination of "shape" has been inferred when a subject did not give discriminative responses during changes 1-3 in the tests for "form *per se*."

Because of the importance of the conclusions reached in these experiments to the more general problems of psychology, a consideration of the validity of the theories of "form *per se*" and "shape" seems necessary at this time.

In the opinion of the writer, the main inconsistency to be found in the belief that some animals respond to "form *per se*" is the fact that adult human individuals are capable of responding to a form "regardless of its position in space and the background upon which it appears" only under very special conditions That is to say, as Mach (13) emphasized, in human perception complex forms appear the same only in the same position, and possess different characteristics when rotated in space (p. 51, 52). The inverted printed page is ample illustration of the fact that there is what may be considered as anisotropy for form in the adult visual field In addition, it is known that most adult individuals find it exceedingly difficult to discriminate forms whose positions are reversed by a mirror, whereas some very young children are not characteristically disturbed by such reversals (4, 19, 24). If the previously mentioned definition of Munn and Steinung (17), as well as that submitted by Gellermann (6) is accepted, the peculiar situation arises in which the responses of young children might be said to be determined by "form *per se*" while those of adults are otherwise controlled, presumably by "shape" On the other hand, it is evident that no response to form is independent of the position of the form

in space and the background upon which it is presented, in the sense that the background or the position could not be changed sufficiently to influence the response. A background could always be so modified or such changes made in position that no discriminative response to a particular pattern of stimuli could be elicited, as Kluver (11) has well pointed out. Hence, it is clear that responses to "form *per se*" are distinguishable only in special cases and, even under these conditions, the validity of the conception may be questioned.

Since only limited kinds of experimental variations have been used by previous investigators in studies of this sort, it is evident that certain presuppositions underlie their attempts to prove that a response to objective visual patterns is determined by either one of two factors, namely, "shape" or "form *per se*." The conclusions reached by the foregoing authors seem to imply, at least to the present writer, that unless a response is determined by the discrimination of the number of sides which a figure may possess ("triangularity *per se*," or the concept of "three-sidedness") there can be no discrimination of form, but only a response to relative size differences ("shape"). That form is not always determined by "sidedness" may be illustrated by the fact that many animals, including human individuals, are capable of discriminating between triangles of different angular relationships and identical triangles in different positions Furthermore, there are many complex forms which are discriminable at once without consideration of the number of lines, curves or angles present. If form involved only responses to the number of physical dimensions present, or was controlled only by a concept of "sidedness," such types of discrimination would be relatively impossible. On the other hand, the monkey which Neet (18) found would respond to "triangularity *per se*" would respond discriminatively as well when a square was substituted for the circle in a triangle-circle combination This fact must mean that, in addition to the number of physical lines, curves, or angles in a particular stimulus pattern, which probably becomes effective only in very special cases of human perception and then possibly through the development of language, there are other factors to be considered as directly related to form discrimination

In view of such considerations as these, it seems that no sharp distinctions are to be drawn on the basis of experimental tests supposedly indicative of a response to "form *per se*" or to "shape."

The fact that Neet (18) found that some monkeys fail to discriminate an inverted triangle and diamond after being trained on an upright triangle and circle does not show, necessarily, that his animals lacked some sort of rudimentary response to form, but only indicates that he arranged spatial relations which were too difficult for his animals to discriminate. If Neet had presented an inverted triangle and ellipse, as has been done in the present experiment with cats, he probably could have argued, on the basis of his own definitions and criteria, for a response to form *per se* in the animals which failed to respond to the triangle-diamond combination. Nor, in the opinion of the writer, does the fact that dogs (10) are capable of discriminating between parts of previously learned figures necessarily indicate a special kind of response to "shape," especially since it has been shown that animals capable of responding discriminatively to what has been considered as form (6, 18) are also capable of discriminating between various types of "equivalent" figures A safe standpoint on this question would seem to be that, until experiments with relative size differences have been carried out and the influence of such changes upon a response determined, as Bingham did with the chick (3), there is no indication that an animal responds to relative size differences or "shape"

In view of the foregoing considerations it has seemed advisable to state the problems approached in the present study in a manner differing somewhat from that of previous investigators. Instead of attempting to find, by selecting certain limited definitions and experimental criteria, whether or not some "all-or-none" response to "form *per se*" can be demonstrated in the cat, the effort here has been mainly to ascertain what factors are involved in visual stimulus patterns producing discriminative responses in this animal In order to do this, selected parts of the total stimulus situation are modified and the resulting influence on the responses noted The variations investigated include the discrimination of visual figures of different sizes, different relative heights, different figure-ground-brightness values, different background features, different "field" brightness values, and different contour. Other factors related to the total stimulus situation could be and are now being studied, but only results relative to the above-mentioned changes are here discussed.

III Apparatus and Procedure

The apparatus employed in the present experiment has been described in a previous paper (22) The animal is trained to depress a small lever below a door upon which a positive stimulus (triangle) is displayed There are two such levers and doors, one set corresponding to the triangle, and the other to a negative stimulus (circle). After being released from a restraining cage placed eight feet in front of the apparatus, the animal, when making a successful response, opens the door corresponding to the triangle by pressing the lever with its forepaw, and thereby receives food located on a shelf behind the door Differential factors other than those related to the figures and which may have been present during training have been found to be ineffective in this situation in a series of check experiments (23)

The subjects used in these experiments were the same as those in a previous study on visual figure discrimination (23). All were animals of unknown pedigree and of different ages. Two of them were trained to respond to black figures on white cards (Subjects 2 and 3) while five learned the discrimination of white figures on black cards (Subjects 1, 4, 5, 6, 7). In both cases the cards were exposed against a homogeneous black ground, 48 inches by 20 inches. The positive figure was a 4-inch equilateral triangle which equaled the negative figure or circle in area (approximately 6 96 square inches) The exposed part of the cards upon which the figures were mounted was 6 inches by 6 inches. The figures were made of smooth drawing paper and so mounted on the cards that their midpoints were of equal heights from the floor

After the subjects had been trained to make the required discrimination between the circle and triangle (18 responses out of 20 correct), and after tests had been carried out to determine the influence of possible differential extraneous factors upon the discrimination, the experimental variations for the study of the animals' responses to form were then begun In these latter tests no electrical punishment was used, as was the case during training with three of the subjects (Subjects 1, 2, 3). With the exception of one series of tests (Tests 11 and 12, Table 2) the door corresponding to the negative stimulus was kept locked, and the animal received food either by going directly to the positive figure, or by

first pressing the lever corresponding to the circle and then going to the door on which the triangle was exhibited.

The food used as incentive throughout the test periods was a commercial brand of cat-food, rolled into small pellets 1/2 inch in diameter, and placed in glass dishes behind both doors. As in previous experiments the animals were kept on a regular diet of milk and cat-food. Each animal received the milk in the early morning and 1/3 pound of cat-food after the experiments in the evening.

All tests or check experiments involved testing the animal on a combination of different types of forms for a period of twenty trials. A retest period of twenty trials, unless otherwise indicated, was then given The number of trials given daily was kept constant, a test period or a retest period of twenty trials being run per day on consecutive days throughout the course of the experiment.

During all of the check experiments the usual controls for extraneous sensory influences were carried out. The animals received no differential auditory stimuli from the apparatus or experimenter, since the subjects themselves manipulated all of the necessary moving parts of the discrimination box when making a response. Olfactory stimuli were kept constant by having food behind both doors. Extraneous visual and olfactory cues were controlled by having two different sets of figures, a positive and a negative stimulus, for each door, so that when an alternation of the figures was required the two exposed cards were removed and the other set inserted in their places. Check experiments have been carried out in which both doors were unlocked Since such changes did not influence the responses of the animals no significant stimuli were obtained from the locked or unlocked door. The animals received no clues from the experimenter when being returned to the restraining cage, as indicated by check experiments in previous studies. The experimenter always stood directly in front of the apparatus when rearranging the cards for the next trial, and always left the room in the same manner. Constant procedure was used in lifting the animal and returning it to the restraining cage In many cases it was not necessary to carry the animal from the discrimination box to the restraining cage, since it would itself return to the front of the room The alternation series was so arranged as to make it practically impossible for the animal to learn the order of shifting the figures This series corresponded to those calculated by Gellermann (7),

which have been designed to give a balanced exchange of the stimuli for the control of position habits. All observations were made from outside the experimental room through an aperture in the door. An error was recorded when the animal touched the lever corresponding to the negative stimulus.

IV. Results

The subjects were divided into two groups for investigation. The first group consisted of three animals, one male and two females, the first of which (Subject 1) was trained to discriminate a white triangle and white circle of equal area exposed on black cards Subjects 2 and 3 had learned the discrimination of a black triangle and circle on white cards. All three animals were shocked during training for a response to the negative stimulus (circle).

The training figures used for these three animals and the various combinations employed for analyzing their responses to form are presented in Figure 1. Combination "S" represents the standard training figures, while the remaining pairs of figures are numbered in the order in which they were introduced, as tests, into the experiment The drawings of the figures are in the relative positions used and are drawn approximately to scale The exact dimensions of the figures were as follows.

S The standard training figures. The triangle measured 4″ on each side and was equated to the circle in area (6 96 sq. in) The midpoints of the two figures corresponded in height and in distance from the sides of the apertures, which were 6″ square.

1. The standard-size triangle lowered 1″ below the midpoint of the circle.

2. The standard-size triangle and circle with the midpoint of the triangle raised 1″ above the midpoint of the circle.

3, 4, 5, 6, 7, 8, 9 Equilateral triangles 3½″, 3″, 2½″, 2″, 1½″, 1″, and ½″ on each side paired with circles of equal area. In these and in the following tests the midpoints of the figures were placed at the same distance from the sides of the apertures.

10. The standard-size triangle and circle exhibited against a white panel on the front of the discrimination box

11 The standard triangle in skeleton form paired with a skeleton circle of such size that it could be circumscribed about the triangle. The skeleton outline was ¼″ wide

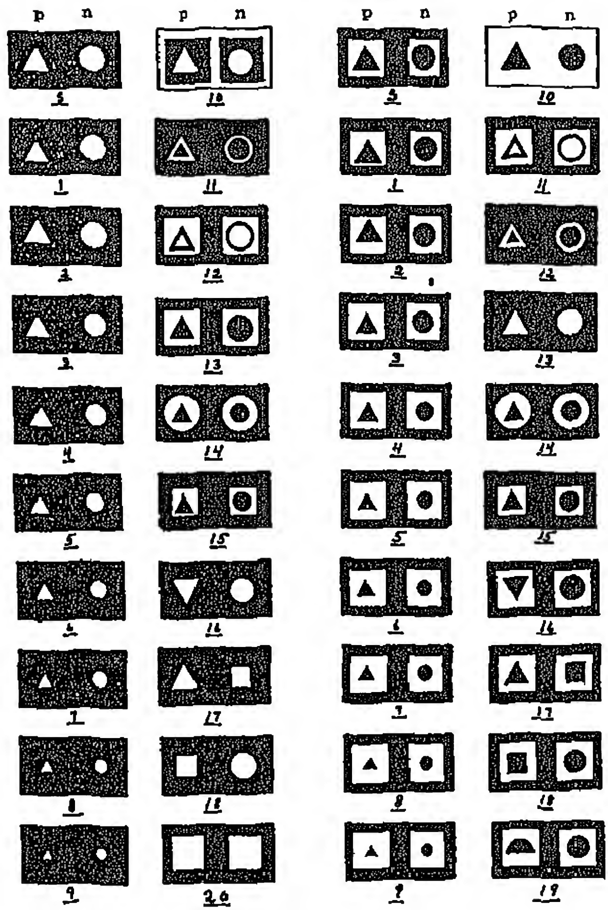

FIGURE 1

12 The skeleton figures employed in test 11 with the black-white relation between the figure and the card reversed

13 The standard-size solid triangle and circle with the black-white relation between the figure and the card reversed

14 A 3″ equilateral triangle paired with a circle of equal area placed inside a circle of 3″ radius. For the first subject the black-white relation between the figure and card was reversed. The

larger forms were also apertures, made by fitting black cardboard containing holes 6" in diameter to the front of the discrimination box

15. The same test as combination 14 except that the smaller figures were placed inside a square, 4" by 4".

16 The standard-size triangle and circle with the triangle inverted

17 The standard-size triangle paired with a square of equal area.

18 The standard circle paired with a square of equal area.

TABLE 1

Experimental variation	Percentage of responses to the triangle in twenty trials S 1	S 2	S 3
S. Standard figures	95	95	90
1 Lowered triangle	90	90	95
2 Raised triangle	90	85	95
Retest	100	95	100
3 3½" triangle	100	100	100
4. 3" triangle	100	95	100
5 2½" triangle	90	85	100
6 2" triangle	90	100	
7 1½" triangle	90	100	
8 1" triangle	90	75	
9 ½" triangle	40	45	
Retest (10 trials)	95	90	80
10. White panel	85	90	100
Retest (10 trials)	90	100	100
11 Skeleton figures	100	70	95
Retest	100	80	80
12. Reversed skeleton figures	80	70	70
Retest	95	85	100
13 Reversed solid figures	90	80	60
Retest	90	95	85
14 Small square grounds	90	90	90
Retest	95	100	100
15 Circular grounds	80	65	80
Retest (10 trials)	80	90	90
16 Inverted triangle	95	85	90
Retest	100	95	100
17 Square for circle	90	75	70
Retest	90	100	85
18 Square for triangle	65	75	80
Retest	80	85	80
19. Semicircle for triangle		90	
Retest		90	
20 White cards	40	50	40
Retest	80	100	100
Trials inclusive of tests	1030	950	1450

19. The standard circle paired with a semicircle of equal area.
20. After the above tests white cards were introduced for all three subjects.

The level of discrimination maintained by the three subjects in different test periods, as well as in retest periods, carried out after some of the above tests had been made, is summarized in Table 1. The figures given represent the percentage of correct responses to the triangle in twenty trials, unless otherwise indicated.

The second group of animals (Subjects 4, 5, 6, and 7) were trained in the discrimination between a white triangle and circle of equal area exposed on black cards. They learned this discrimination without punishment by electric shock These animals were also "overtrained" as compared with the first group of subjects, since they were presented with the training figures until there was 100 per cent discrimination between the figures in 100 trials All animals were able to fulfill this criterion except one, which responded in only 95 per cent of the cases to the triangle alone The number of trials in excess of a 90-per cent criterion of learning required by the subjects to reach a 100-per cent criterion over a period of 100 trials amounted to 200, 240, 200, and 200 trials for the respective subjects

The tests used for the analysis of form discrimination with these four animals differed in some respects from the tests employed with the first group of subjects. Figure 2 presents the standard training figures and the various combinations used for the analyses of the animals' responses to the total situation In the following summary the exact dimensions of the different visual stimuli are given:

S. The standard training figures. The triangle measured 4″ on each side and was paired with a circle of equal area. The midpoints of the figures corresponded in distance from the four sides of the apertures.

1. The standard circle paired with a triangle 2″ on each side.
2. The standard-size triangle in skeleton form paired with a skeleton circle of such size that it could be circumscribed about the triangle. The skeleton outline of both figures was ½″ wide.
3. The same test as combination 2 except that the black-white relation between the figure and the card was reversed.
4. The standard size solid figures with the black-white relation between the figure and the card reversed

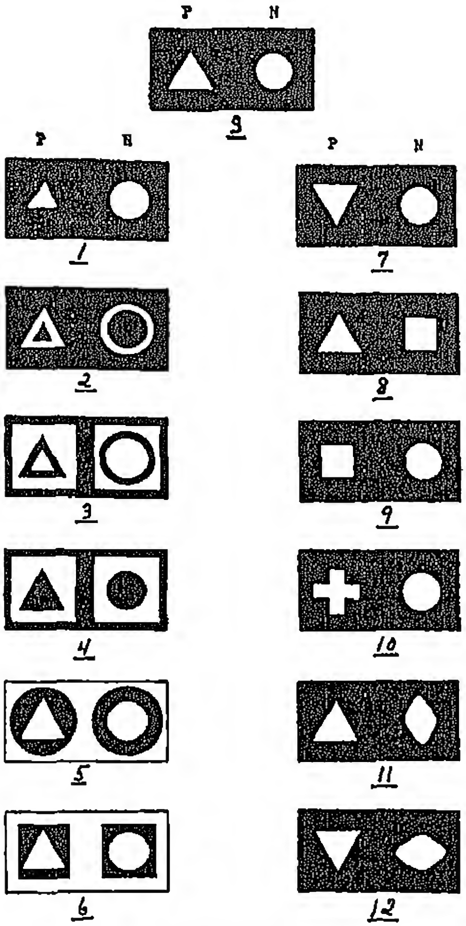

FIGURE 2

5. The standard-size solid figures exposed in black circular grounds, 6″ in diameter, against a white panel on the front of the discrimination box. The white panel was obtained by covering the front of the discrimination box with stiff white cardboard, in which the circular apertures were so cut that they corresponded to the position of the apertures of the discrimination box.

6. The same test as combination 5 except that the figures were presented inside a small square, 5" by 5".
7. The standard training figures with the triangle inverted.
8 The standard triangle paired with a square of equal area.
9. The standard circle paired with a square of equal area.
10. The standard circle paired with a cross of equal area.
11. The standard triangle paired with an irregular elliptical figure of equal area
12. The standard triangle inverted and paired with the elliptical figure used in test 11, rotated through 90 degrees.

After the above tests had been made, retention experiments were carried out with two animals. Subject 5 was retested on the standard training figures exactly one year after the time when the last

TABLE 2

	Experimental variation	Percentage of responses to the triangle in twenty trials S 4	S 5	S. 6	S. 7
S	Standard figures	100	100	100	100
1	Small triangle	100	100	95	85
2	Skeleton figures	95	95	100	100
	Retest	100	95	100	100
3	Reversed skeleton figures	100	85	95	100
	Retest	100	100	100	95
4	Reversed solid figures	85	95	95	100
	Retest	100	100	90	95
5.	Circular grounds (white panel)	90	85	85	90
	Retest	100	80	95	100
6	*Small square grounds* (white panel)	100	85	90	100
	Retest	100	90	100	
7.	Inverted triangle	95	100	95	85
	Retest	100	100		100
8.	Square for circle	90	70	80	80
	Retest	100	100	100	95
9.	Square for triangle	70	70	75	65
	Retest	90	100	100	100
10	Cross for triangle	80	75	55	75
	Retest	90	100	95	100
11	Ellipse for circle	100	100		85
12	Inverted triangle and rotated ellipse	100	95		85
	Retention		90		65
	Retention		95		90
	Retention		100		90
	Retention				85
	Trials inclusive of tests	1000	980	1060	1100

test for form discrimination was made (Dec 6, 1932—Dec 6, 1933), Subject 7 was retested seven months after the earlier experiments (March 7, 1933—Dec 6, 1933) Table 2 presents a summary of the individual performances of the various subjects throughout the test and retest periods, as well as during the time when the retention experiments were carried out The values appearing in the table represent the percentage of responses to the arbitrarily chosen positive figure in blocks of 20 trials each.

V Summary and Conclusions

In the opinion of the writer the data presented in the foregoing section warrant the following general statements relative to the nature of form discrimination in the cat.

The animals trained in these experiments continued to make discriminative responses when the figures were reduced in size (Tests 3-9, Table 1). The three subjects investigated were able to discriminate respectively, 1", 1½", and 2½" equilateral triangles and circles equated in area. Under similar conditions Neet has shown that four monkeys responded discriminatively when equilateral triangles 5" to 2.8" on each side were presented with circles equated in area On the basis of these limited results no marked differences have been brought out between the range of effectiveness of figures of different size in the monkey's and cat's discrimination of form

The results show that cats do not respond to "shape" in that their responses are based upon a "keen perception of size differences," as Bingham (1, 2, 3) held was the case with chicks. Various experiments were made in the attempt to investigate thoroughly whether or not the range of effectiveness of the circle and triangle was confined to certain relative size differences The relative size differences were so modified that the distribution of brightness of the circle was both greater and smaller than that of the triangle (Tests 11, 12, Table 1, Tests 1, 2, 3, Table 2). Most of the subjects used in these tests gave no marked changes in the behavior or in the percentage of discriminative responses to the triangle In addition, the triangle was inverted (Test 16, Table 1, Test 7, Table 2). A variation somewhat similar to that which Neet (18) has described as a "crucial" test for ascertaining a response to "shape" was also carried out with the second group of animals This involved presenting an inverted triangle and simultaneously substitut-

ing in place of the circle a new figure of different distribution of energy (Test 12, Table 2). In general, the subjects responded as well during this change as in the previous experiments with relative size differences. It may be concluded, therefore, that the factor of "shape" is unimportant in evaluating the cat's responses to form under the conditions in which these experiments were carried out.

The conclusion may also be drawn from the summarized data that cats discriminate form in the sense that certain visual contours appear to be one of the variables in a total stimulus situation upon which their responses to that situation are dependent, and also in the sense that these responses may be observed when similar objective stimulus patterns are presented under different conditions of size, brightness, position, etc As far as this and other studies, using somewhat similar methods, have analyzed the responses of various animals to stimulus situations involving form, no marked differences have been found between the responses of the cat and those which may be observed, for instance, in the monkey (Neet) or chimpanzee (Gellermann) That is, a total stimulus situation may be arranged in which cats can respond discriminatively to patterns of energy in the visual field when experimental variations are introduced involving changes (*a*) in the relative heights of the figures (Tests 1, 2, Table 1); (*b*) in the absolute size (Tests 3-9, Table 1), (*c*) in the relative size (Tests 11, 12, Table 1; Tests 1, 2, 3, Table 2), (*d*) *in the luminosity of the area surrounding the figures and cards* (Test 10, Table 1; Tests 5, 6, Table 2); (*e*) in the luminosity relationship between the figure and the card (Tests 12, 13, Table 1, Tests 3, 4, Table 2); (*f*) in a larger form surrounding the figures (Tests 14, 15, Table 1, Tests 5, 6, Table 2), (*g*) in the position of the triangle (Test 16, Table 1; Test 7, 12, Table 2); (*h*) as well as in the form of the figures to a limited degree (Test 19, Table 1; Tests 11, 12, Table 2). In the main, the responses found in these experiments were specific to forms with particular physical contours, and generally non-specific to forms of different size, position, brightness, figure-ground relation, etc A square or cross substituted for either the triangle or circle (Tests 17, 18, Table 1; Tests 8, 9, 10, Table 2) influenced the level of discrimination more than did the introduction of figures more closely related to the triangle or circle, as, for instance, a semicircle or ellipse (Test 19, Table 1, Tests 11, 12, Table 2). There is some evidence, therefore,

that, within the limits of the changes made in these experiments, the behavior of the animals was based to some extent upon the presence of particular contours of differential patterns of energy in the total stimulus situation. That the factor of number of sides ("Triangularity *per se*") was insignificant in controlling the responses was demonstrated by the fact that some animals did not respond discriminatively when three-sided and four-sided figures were presented (Test 17, Table 1, Test 8, Table 2), and by the ability of one animal to respond discriminatively when a semicircle was substituted for the triangle (Test 19, Table 1). Apparently, the cat's discrimination of the visual contours of triangles and closely related forms is not characterized by anisotropy when these forms are paired with circles or ellipses (Test 16, Table 1, Tests 7, 12, Table 2)

It is believed that the foregoing conclusions are not altered by any statement to the effect that the animals' responses were based upon only a single figure, either circle or triangle The fact that different "new" figures give different levels of discriminative response suggests that, at any instant, the behavior is dependent upon the figures exhibited during a particular test trial and those learned in the original discrimination In other words, the effectiveness of a square or an ellipse in determining the discriminative response is derived both from its relation to the other figure presented on the discrimination apparatus and the figures which were learned during the original learning period It would seem that similar reasoning could also be applied profitably to the cases in which a larger form was introduced as a "background" (Tests 14, 15, Table 1, Tests 5, 6, Table 2)

No significant differences were brought out between the behavior of animals trained to an easy learning criterion (90-per cent discrimination between the figures in 20 trials) and that of subjects trained to a more difficult criterion (100-per cent discrimination in 100 trials) The differences brought out were confined to experiments with skeleton figures (Tests 11, 12, Table 1, Tests 2, 3, Table 2) and with new figures (Test 17, Table 1, Test 8, Table 2). In these tests animals trained to respond to black forms on white cards until they had fulfilled an easy learning criterion gave fewer differential responses to the substituted forms In other respects the relative change in the level of discrimination as different form combinations were introduced is similar for the two groups. The data

consequently do not establish, so far as the changes made here are concerned, any proof that responses become a great deal more specific with greater amounts of training, or that with more training the capacity to react to triangles and circles during changes in an experimental situation is facilitated, as Fields (5) has emphasized in studies with the rat. But on the whole, the question of the effects of training upon the effectiveness of different variables in a total stimulus situation requires more extensive experimentation than has been carried out here

Two animals were tested for discriminative responses to the training figures after the passage of 12 months' and 7 months' time respectively (Table 2) Both animals readily learned to respond to the original training figures with a level of accuracy comparable to that found during the earlier test periods Subject 5 responded 95 per cent of the time to the triangle alone in the first series of twenty trials given during the retention tests Subject 7 reached a level of 90-per cent responses to the triangle in the second series of 20 trials given during these tests.

In the opinion of the writer, the results of the present study suggest that objection may be raised to any attempt to establish, on the basis of arbitrary definitions and experimental criteria, whether or not certain organisms respond to form *per se*, brightness *per se*, or make other sorts of abstractions and generalizations. For, by selecting different experimental criteria, entirely different conclusions as to the nature of the abstractions can be reached. Such statements do not mean, however, that the results on "equivalence" of visual forms, as found for the cat in this study, are not important in relation to the psychological problems of abstraction, generalization, conception, and even reasoning, since, as shown clearly and forcibly in the writings of Rignano (21), and similarly in more recent studies (11), these assumed processes and mechanisms consist, basically, in the reduction of varied types and classes of stimuli to an "equivalent" (21) or "representative" (9) status The general factors involved in this "equivalence" or "representativeness" of different stimuli in the behavior of the cat will be dealt with in reports of experiments now in progress.

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LA DISCRIMINATION VISUELLE CHEZ LE CHAT: II. UNE AUTRE ÉTUDE DE LA CAPACITÉ DU CHAT POUR LA DISCRIMINATION VISUELLE DES FIGURES

(Résumé)

Cet article rapporte une seconde série d'expériences faites dans le but de déterminer les facteurs qui sont importants dans le contrôle des réponses du chat à la forme On a testé sept animaux, entraînés à discriminer entre un triangle équilatère de 4 pouces et un cercle d'une aire égale, dans des situations où il s'agit des changements dans (*a*) les hauteurs relatives des figures, (*b*) la grandeur absolue, (*c*) la grandeur relative, (*d*) la clarté du fond, (*e*) la relation noire-blanche entre la figure et le fond, (*f*) la forme de plus grandes figures entourant le cercle et le triangle, (*g*) la position du triangle, (*h*) la solidité des figures, (*i*) la forme des figures

Les conclusions tirées des résultats sont les suivantes (1) les chats possèdent une acuite visuelle pour la discrimination des cercles et des triangles de petite grandeur comparable à celle trouvé par d'autres travailleurs chez le singe, (2) On n'a obtenu aucuns temoignages que les réponses des animaux dépendent des différences relatives de grandeur, ou "forme", (3) Les données montrent que certains contours visuels, qui constituent un aspect de la forme mais indépendant d'une propriété abstraite "forme *per se*," sont significants dans la détermination des réponses trouvees

SMITH

OPTISCHE UNTERSCHEIDUNG BEI DER KATZE II EINE WEITERE UNTERSUCHUNG DER FAHIGKEIT ZUR VISUELLEN FORMUNTERSCHEIDUNG BEI DER KATZE

(Referat)

Dies ist ein Bericht uber eine zweite Reihe von Experimenten zum Zweck der Feststellung, welche Faktoren in den optischen Reizgestalten wichtig zur Kontrollierung der Reaktionen der Katze auf Form sind Sieben Tiere, welche zur Unterscheidung zwichen einem gleichseitigen Dreieck (4

inches) und einem Kreis desselben Flächeninhalts dressiert wurden, wurden in Situationen untersucht, wo Veränderungen vorkamen in (*a*) den relativen Höhen der Figuren, (*b*) der absoluten Grösse, (*c*) der relativen Grösse, (*d*) der Helligkeit des Hintergrundes, (*e*) dem Schwarz-Weiss Verhältnis zwischen Figur und Grund, (*f*) der form der grösseren den Kreis und das Dreieck umgebenden Figuren, (*g*) der Lage des Dreiecks, (*h*) der Festigkeit der Figuren, (*i*) der Form der Figuren

Die Schlüsse, die aus diesen Ergebnissen gezogen wurden, sind folgende (1) Die Katzen besitzen eine optische Schärfe zur Unterscheidung von Kreisen und Dreiecken kleiner Grösser vergleichbar der von anderen Forschern gefundenen Unterscheidung beim Affen; (2) Kein Beweis wurde gefunden, dass die Reaktionen der Tiere von den relativen Grössenunterschieden oder der "Gestalt" abhängig sind, (3) Die Daten zeigen, dass gewisse visuelle Umrisse, welche eine Seite der Form ausmachen, aber unabhängig von einer abstrakten "Formeigenschaft" an sich sind, sind wichtig zur Bestimmung der gefundenen Reaktionen

SMITH

FOOD ORIENTATION AS A FACTOR DETERMINING THE DISTRIBUTION OF ERRORS IN THE MAZE RUNNING OF THE RAT*

From the Psychological Laboratories of the University of California[1]

E. L. BALLACHEY AND JACK BUEL

As early as 1917 Hubbert and Lashley (8) pointed out that in the Watson circular maze rats ran with their heads close to the inner alley walls The food in this maze was located in the center of the maze. It was assumed that the rats were oriented to the food position This behavior may also be attributed to the fact that following the inner wall is the shortest path to the goal

Lashley (9) reports the following observation Twenty rats which had learned a maze were blocked at the entrance and allowed to escape to the top of the maze. Five of the rats took the most direct path to the food box, and exhibited practically no random exploration. Three rats reached the food by random exploration and the remainder of the group dropped into the first alley and ran the maze in the usual manner Lashley admits that the probability of such a result occurring by chance cannot be computed, but says, "the behavior of the five that followed the direct course to the food strongly suggested that they were perfectly oriented with respect to its direction, although they had never before reached it save by the indirect path of the maze" Lashley concludes that, "The available evidence seems to justify the conclusion that the most important features of the maze habit are a generalization of direction from the specific turns of the maze."

Dashiell (5) has made a most extensive study of direction orientation. Using an open-alley maze which allowed the rat to reach the food by many equally long paths, he found that the rats took a variety of paths which did not involve excess distance though the opportunity for taking such paths was present He concludes from

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[1]The writers are greatly indebted to Professors Warner Brown and R C Tryon for advice and criticism during the preparation of this paper.

this and other studies that "the rat when running the maze early shows the influence of some direction-orienting tendency that operates independently of specific stimuli to particular local movements, and enables it, when physical conditions permit, to pursue pathways never before trod, yet without false turns or wrong direction." Bledsoe, Blodgett and McGarrity (3) have attempted to isolate the factor of distance from that of orientation. They used a circular maze made up of twelve concentric circles. "The path in one-half of the circles was equal, and in one-half was not. This enables the animals to respond in some of the circles in the direction away from food without involving the traversal of a greater distance. They were also allowed to respond in some of the circles in the direction of the shorter distance." They found that the choices in the direction of food in the equal alleys were only .18 sigma greater than would be expected by chance alone. The responses into the short alleys over the long alleys exceeded chance by 8.63 sigma irrespective of whether the alleys were food pointing or non-food pointing. This suggests that excess distance may be a more important factor than food orientation.

Luh and Shen (10) have offered evidence which seems to explain the actual mechanisms involved in Dashiell's direction orientation study in the open-alley maze. These experimenters have been able to account for the variable paths of the animals through the open-alley maze as due mainly to two specific factors (i.e., forward-going tendency and positional preferences). They say, "There is no reason why this tendency[2] (forward-going tendency) alone should not be sufficient to account for the non-stereotyped yet errorless runs." Luh and Shen observed that the ratio of the number of stereotyped runs to the total number of errorless runs decreased. From this, the authors tentatively concluded that "there seems to be another 'determining tendency' which controls the bodily turns of the animals in a more flexible and general way. It enables the animal to take variable routes toward the same goal." The increase in variability is not marked, however, and the authors do not conclude that this "determining tendency" is a *general* orientation.

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[2]Recent experiments and analysis by Schneirla (11), Ballachey and Krechevsky (2), and Ballachey and Buel (1) have more adequately determined the mechanism of this tendency and have revealed that the causal factor is the bodily displacement of the animal in the choice alley. This explanation has been termed centrifugal swing.

Washburn and Ebersbach (18) found that when the initial pathway pointed in the direction of the goal more errors were made into food-pointing blinds than when the initial pathway pointed in the direction opposite to the food position. This work was in the nature of a preliminary study, and definite conclusions cannot be made.

Higginson (7), Helson (6), and Shepard (12) have reported cases of insightful behavior which may also be interpreted as evidence for general orientation It should be pointed out, however, that Valentine (17) repeated Higginson's experiment and obtained negative results.

Experiments using T-mazes have also indicated the presence of general orienting factors. Yoshioka (19) found that if the goal direction in a T-maze is clockwise, more errors are made into the clockwise blinds. He concludes "that the rats are sensitive to a goal-direction in the maze, and a learning of the goal-direction plays a part in maze solution."

Tolman and Honzik (14, 15) in two studies on the effect of drives on the maze learning of rats have reported results indicating that the percentage of errors into food-pointing blinds is greater than the percentage of errors into the non-food-pointing blinds Further, they have indicated that a hungry rewarded group (HR group) made a greater percentage of errors into the food-pointing blinds than a hungry non-rewarded group (HNR group). However, they say, "it is not asserted that *greater* difficulty of learning is caused entirely, or even mainly, by the fact that blinds point *toward food or exit* Other factors besides food and exit *may* help to make the food-exit pointing blinds more difficult to eliminate" The maze pattern used by Tolman and Honzik was the same as that used by Yoshioka (19) In a study on the effect of change of reward Tolman and Honzik (15) found that the entrances into food-pointing blinds in the reward period were greater than the number of entrances into the blinds in the non-reward period. They concluded from this that the increased drive caused errors to increase in the food-pointing blinds. Most of these studies have seemed to indicate that food orientation plays an important rôle in determining the distribution of errors in the maze, and the *relative difficulty* of the various blinds

The studies cited above have, for the most part, involved the use

of complicated spatial situations or complex mazes in which complicating factors may be operative. A study involving a simple spatial set-up was made by Yoshioka (20). This experimenter used a maze made in the form of a diamond with an exit alley at an apex of the diamond (20, Figure 1). The food was placed at various degrees to the right or left of the long axis of the maze. When the diamond involved a choice between two alternative alleys food orientation was not obtained. When the diamond was an open space Yoshioka obtained what he concluded was orientation to the food direction, as expressed by the deviations of the rats' paths in the open space of the diamond. However, when differential illumination of the maze was controlled the critical ratios between the obtained orientation paths and the number of such paths to be expected by chance was 1.82. This does not indicate what is usually considered a statistically significant difference. This result is in accord with the results of an earlier experiment by Yoshioka (15) where food-orientation was not demonstrated in a simple diamond-maze situation.

Buel and Ballachey (4) have reported an experiment using a set-up somewhat similar to Yoshioka's but more complicated in that it contained two diamond units one of which was an open space and the other a two-alley choice situation. It was found by these experimenters that when food was displaced 90° to the right or the left of the long axis of the maze no orientation to the food direction was obtained. In another study by Ballachey and Buel (1) it was found that general direction orientation was less effective in determining the choices of the rats than the specific factor of centrifugal swing.

These considerations have led the present writers to the belief that general direction orientation may be less effective in determining the relative difficulty of blinds in the maze than has heretofore been thought. In order to examine the effect of food orientation we have made an analysis of the distribution of errors in a complex T-maze. Professor E. C. Tolman and Dr. Charles Honzik have very kindly allowed us to use their original data on the experiments reported above. Professor Tolman has suggested that a correlational analysis of these data be made. We are, therefore, indebted to Professor Tolman for the opportunity to make this study.

The statistics below were obtained from the first eleven trials of

the Tolman and Honzik studies (14, 15). The data have been taken from both experiments In the first experiment on the effect of degrees of hunger, reward, and non-reward on maze learning, four groups were employed. (1) less hungry non-reward; (2) less hungry reward; (3) hungry non-reward, (4) hungry reward These groups are designated as LHNR, LHR, HNR, and HR, respectively.[8] In the second study on the effect of introduction and removal of reward on maze performance two groups were employed (1) hungry reward-non-reward, and (2) hungry non-reward-reward. Because we *are using the first eleven trials only, that is, before the introduction* and removal of reward of the above groups, these two groups will in this paper be referred to as hungry reward, and hungry non-reward groups (HR and HNR) Thus, we have been able to combine the hungry reward group of the first study with that of the second, and the hungry non-reward group of the first study with the second since these groups ran the same maze under the same conditions. The number of animals in the groups are given in Table 1.

TABLE 1

	Schedule of groups			
Groups	HR	HNR	LHR	LHNR
N	77	77	36	36

The error scores used in the following statistics do not include retracing errors The total number of errors for each of the fourteen blinds of the maze were tabulated. All correlations in the following tables are product-moment correlations

Table 2 presents the correlations between the distribution of errors in the 14 blinds on the first trial and the distribution of errors in the blinds for trials 2-11. Since we are correlating blinds, N equals 14, the number of blinds in the maze. The number of rats is comparable to the number of items in a test, and the blinds are compar-

[8]The HR group animals were fed their daily ration (such an amount as to cause a decrease in weight during the experiment) of modified Steenbock mash in the food box at the end of the run The HNR group was fed in the *living cages* not less than 3 and not more than 4 hours after the daily run. The rats of this group were run to boxes at the end of the maze in which food had never been placed The LHR group was fed in the food box at the end of the maze This group was fed such amounts of mash as to cause the rats to increase in weight during the experiment The LHNR group was fed, in the living cages, a ration equal to that given the LHR group, and was always fed from 3 to 4 hours after the maze run

TABLE 2

THE CORRELATIONS BETWEEN THE DISTRIBUTION OF ERRORS ON THE FIRST TRIAL AND THE DISTRIBUTION OF ERRORS ON TRIALS 2-11*

	Groups			
	HR	HNR	LHR	LHNR
Uncorrected r's	78	77	72	68
Corrected r's	83	79	74	70

*All correlation coefficients in this table and in the following tables are positive

able to the number of individuals in the usual test situation It will be seen that the uncorrected correlations range from +.68 to +.78. The corrected r's are given in the second row of the table[4] The corrected r's are an estimation of the correlations for an infinite population of rats and are not comparable to the raw r's It will be seen that all the corrected r's are +.70 or greater. Thus, the factors which determine the distribution of errors on the first trial are to a large extent the same systematic factors which are present in later trials It should be noted that during the first trial the rats presumably have no goal orientation, yet the correlations indicate that the distribution of errors is very much like the distribution of errors in the later trials when orientation should be operative It is, of course, true that these correlations are not great enough to allow us to argue that no orientation is present on later trials We should expect, however, if goal orientation is an effective variable, that the correlation for the hungry reward group would be lower than the correlation for the hungry non-reward group. As may be seen, this is not the case, the two correlations being +.83 and +.79, respectively[5] Likewise, the correlation between the first

[4]The probable errors of the correlations reported here are meaningless and have not been computed The assumption of the probable error technique is that the sample dealt with is a *random* selection from the universe The 14 blinds we are here considering are a unique sample and are not a *random* selection

[5]The corrected r's in Table 2 were computed using the formula derived by Dr R C Tryon The usual formula for the correction for attenuation is not applicable to these data because the *same* rats were employed in getting the two measures from which the *raw* intercorrelations were calculated whereas different rats were used in the two measures from which the reliability coefficients were calculated The reliability of a group for the first trial was obtained by halving the sample (x_1, x_2) and the reliability coefficient for trials 2-11 was obtained in the same way (y_1, y_2) In order that the same test items (rats) should not be present in the intercorrela-

trial and the later trials for the less hungry rewarded group should be lower than for the less hungry-non-rewarded group If general orientation is increased by increasing the reward-value of the goal, the distribution of errors for trials 2-11 for the LHR group should be different from the distribution of errors on the first trial. The differential effect of orientation in later trials would, of course, lower the correlation between the first and later trials. It is seen that this is not the case, the correlation for the LHR group being of the same magnitude as the coefficient for the LHNR group. Thus we see that goal orientation is not affected by the presence or absence of reward, nor is it affected by differences in the degree of drive

Table 3 presents the intercorrelations between the various groups

TABLE 3
THE INTERCORRELATIONS BETWEEN THE GROUPS FOR THE ERROR DISTRIBUTION OF THE FIRST TRIAL

Groups	HR	HNR	LHR	LHNR
HR	**.91**	**.93**	**.90**	**.83**
HNR	*1.00*	**.96**	**.97**	**.95**
LHR	*.96*	*1.01*	**.97**	**.95**
LHNR	*.90*	*1.00*	*1.00*	**.93**

for the distribution of errors on the *first* trial. The uncorrected correlations are in bold type and the correlations corrected for attenuation are in italics. It will be seen that the reliability coefficients for the various groups are all above +.91 These reliabilities were computed by correlating the distribution of errors for a chance selection of one-half the animals of each group with the other half of the group The reliability of the whole sample was obtained by

tions and spuriously raise the correlation, x_1 was correlated with y_2 and x_2 with y_1, where x_1 and y_1 are the error scores of the same rats for trial 1 and trials 2-11 respectively. The formula for correction for attenuation is as follows:

$$r_{\infty} = \frac{\dfrac{r_{x_1y_2} + r_{x_2y_1}}{2}}{\sqrt{r_{x_1x_2}\, r_{y_1y_2}}}$$

The reliability coefficients in the denominator are the reliabilities of one-half the sample, i e, the S-B formula has not been used to obtain the reliability of the entire sample. The reliabilities of the halves are used because the correlations in the numerator are the coefficients between halves

the use of the Spearman-Brown formula. These high reliability coefficients indicate that the distribution of errors on the first trial is almost entirely due to systematic factors and that the rôle of chance factors is negligible. Chance factors have been generally postulated as largely determining the error distribution of the first trial. On the contrary, these obtained reliability coefficients indicate that the rats' behavior on the first trial is determined almost entirely by *systematic factors which are either inherent in the maze pattern* or which the rats bring to the maze. Tryon (16) has obtained similar results and has postulated a number of factors to account for the systematic behavior on the first run.

The corrected correlations between groups are, with the exception of the correlation between the HR and LHNR groups, all above +.96, while four of the six correlations are unity. The intercorrelations indicate that the distribution of errors is ***entirely*** determined by systematic factors which are the same for all groups.

Table 4 presents the intercorrelations between groups for trials

TABLE 4

THE INTERCORRELATIONS BETWEEN THE GROUPS FOR THE ERROR DISTRIBUTION OF TRIALS 2-11

Groups	HR	HNR	LHR	LHNR
HR	*.99*	**.97**	**.98**	**.94**
HNR	*.98*	*.99*	**.96**	**.95**
LHR	*.99*	*.98*	*.98*	**.97**
LHNR	*.95*	*.96*	*.99*	*.97*

2-11. The bold-faced type coefficients are uncorrected and the italicized coefficients are corrected for attenuation. The reliability coefficients (the reliabilities were obtained in the same manner as those in Table 3) are all above +.97. It is clear that the distribution of errors is wholly due to systematic factors during the later trials, though these are not entirely the same factors that are present in the first trial. This is indicated by the correlations given in Table 2. The corrected intercorrelations are all above +.95. We now have definite proof that, in this maze, the distribution of errors cannot be due to *food* orientation. The intercorrelation between the HR and HNR group is +.98 and between the LHR and LHNR groups the correlation is +.99. Thus, the correlations indicate that the presence or absence of reward has not influenced

the relative difficulty of the blinds The order of difficulty of the blinds is the same in all four groups. It is recognized that the percentage of errors into the food-pointing blinds varies with fluctuations in the reward, but the relative difficulty of the blinds is *not at all affected.* Differences in degree of drive are also found to be inoperative in effecting a change in the distribution of errors. It will be noted that all of the correlations in Table 4 are practically of the same magnitude, and that there is no consistent change due to differences in degree of drive.

Tolman and Honzik found it necessary to postulate an exit orientation ("outlet-seeking impulse") to account for the fact that non-reward groups displayed a larger percentage of entrances into the exit-pointing blinds than would be expected by chance It might be argued that because exit-seeking and food orientation are perfectly correlated (due to the fact that food is at the exit) the addition of the reward to the exit-seeking factor in the rewarded groups would not vary the relative difficulty of blinds and hence would not affect the correlations. But this argument can be shown to be fallacious. Let x = exit-seeking, and y = food orientation $r_{xy} = 1.00$, because, as pointed out above, both exit and food are in the same location in the maze From the intercorrelations between the error distribution on the first trial and trials 2-11, we may postulate that the error order of the maze is determined in the non-rewarded groups by *exit-seeking plus a number of other systematic factors* (x, a_1, b_1, c_1 . . . . n_1) and the error order of the rewarded groups is determined by exit-seeking, other factors, *and food orientation* (x, a_2, b_2, c_2 . . . . n_2+y). Since r_{xy} is unity, the addition of y in the *rewarded* groups must necessarily *heavily* weight the exit-food orientation factor Such weighting, because of its magnitude, should result in a different error order for the blinds of the maze from that obtained when exit-seeking is present, but not food orientation (non-rewarded groups) and result in lowered correlations between the rewarded and non-rewarded groups But, as may be seen in Table 4, the correlations between the rewarded and non-rewarded groups are practically unity. What effect would different weightings of x and y have on the correlations? One possibility is that both x and y are negligible factors, i.e., insignificantly weighted If this be true, then the relative distribution of errors is not due to food-orientation nor exit-seeking, but to other factors A second possibility is

that x is heavily weighted and y is insignificantly weighted This would result in no change in the correlations If both x and y were heavily weighted, then the correlations between the HR groups and the HNR groups should be lowered Likewise, if exit orientation is a negligible factor and food orientation is heavily weighted the correlations should be lowered But the correlations remain constant and practically unity This means that food orientation is, for this maze, not an effective variable in determining the relative difficulty of the blinds[6]

Spence (13) has used the data of Tolman and Honzik in his analysis of factors determining the relative difficulty of blinds in maze learning He obtained rank order correlations between the experimentally obtained order of difficulty of blinds (presumably for the HR groups) and the theoretical order of difficulty to be expected if the goal-gradient mechanism and goal orientation were the sole determiners of the relative difficulty of the blinds The correlations he got were +.90 and +.91 The writers have computed the correlation for the HNR group This correlation is +.92 and definitely proves that the "goal orientation" of Spence is *not food orientation.*

The correlation between the theoretical order determined by Spence and the obtained order of difficulty for the first trial computed by the present writers proved to be +.65 for the HNR group and +.66 for the HR group These correlations indicate that a number of specific factors unrelated to the goal gradient and goal orientation (because they are present in the first trial) tend, because of the maze design, to produce a distribution of errors similar to the distribution to be expected from the goal-gradient mechanism and goal orientation Therefore, the correlations which Spence has obtained are spuriously high and do not accurately indicate the importance of the factors of goal-orientation and the goal gradient.

The above results indicate that general food orientation is not effective in determining the relative difficulty of blinds in this maze Earlier investigators employing the method of averages have obtained significant differences between the average number of errors into food-pointing blinds and non-food–pointing blinds As is generally recognized, the method of averages does not indicate the degree to

[6] The writers are indebted to Mr George Kuznets for this argument

which one variable is associated with the other The correlation method, on the contrary, enables one to ascertain the degree to which individual differences in one variable are associated with individual differences in a second variable The older studies of direction orientation employing the method of averages have, it would seem, exaggerated the importance of general maze orientation as a factor influencing the differential difficulty of blinds in the maze

Summary

Studies on orientation in simple spatial situations have seemed to indicate that general food orientation is difficult to obtain This suggested that further analysis of food orientation in the maze might indicate the importance of this factor in determining the differential difficulty of blinds. A correlational analysis of the distribution of errors obtained for four groups run in a fourteen-unit T-maze under different conditions of drive and reward has revealed that the relative difficulty of blinds in this maze is not determined by food orientation.

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L'ORIENTATION VERS LA NOURRITURE COMME FACTEUR DANS LA DÉTERMINATION DE LA DISTRIBUTION DES ERREURS DANS LE PARCOURS DU LABYRINTHE PAR LE RAT

(Résumé)

Une analyse corrélée de la distribution des erreurs dans un labyrinthe en forme de T composé de 14 parties pour quatre groupes qui ont fait le parcours dans des conditions différentes de récompense et d'impulsion (on a obtenu les données des études de Tolman et de Honzik) montre que l'ordre des erreurs des culs-de-sac pour la première epreuve donne une corrélation de +0,70 à +0,83 avec la distribution des erreurs pour les épreuves 2-11. Ces coefficients indiquent un assez grand caractère commun entre la première épreuve et les épreuves suivantes Les coefficients de constance pour la distribution des erreurs de la premièr épreuve varient entre +0,91 et +0,97 Ces coefficients indiquent que la distribution des erreurs de la première epreuve est presque entièrement due à des facteurs systématiques Les r's corrigés entre les groupes pour la distribution des erreurs de la première épreuve varient entre +0,90 et +1,00 Ces corrélations indiquent que la distribution des erreurs pour l'epreuve 1 est *entièrement déterminee par des facteurs systématiques communs aux groupes.* Les coefficients de constance pour les épreuves 2-11 sont tous plus élevés que +0,97. Les r's corrigés entre les groups pour la distribution des erreurs des épreuves 2-11 varient entre +0,95 et +0,99 Parce que les corrélations

entre les groupes qui ont fait le parcours *pour une récompense* et ceux qui ni l'ont fait *pour aucune récompense* sont de +0,98 et +0,99, on conclut que la difficulté relative des culs-de-sac n'est pas determinée par l'orientation générale vers la nourriture L'intercorrélation entre les groupes pour les épreuves 2-11 indiquent aussi que les différences dans l'impulsion ne causent par de différences dans la difficulté relative des culs-de-sac

BALLACHEY ET BUEL

FUTTERORIENTIERUNG ALS EIN FAKTOR ZUR BESTIMMUNG DER VERTEILUNG DER FEHLER BEI DER IM LABYRINTH LAUFENDEN RATTE

(Referat)

Eine Korrelationsuntersuchung der Fehlerverteilung in einem 14-fachen T-Labyrinth bei vier Gruppen von Ratten, die unter verschiedenen Umstanden von Belohnung und Antrieb gelaufen sind (Daten aus den Arbeiten von Tolman und Honzik) zeigt, dass die Fehlerreihenfolge der blinden Gange fur die erste Probe von +0,70 bis +0,83 mit der Fehlerverteilung fur Proben 2-11 korreliert Diese Koeffizienten weisen auf ein ziemlich grosses Verhaltnis zwischen der ersten Probe und den spateren Proben hin Die Zuverlassigkeitskoeffizienten fur die Fehlerverteilung der ersten Probe erstrecken sich von +0,91 bis +0,97 Diese Koeffizienten zeigen, dass die Fehlehverteilung der ersten Probe beinahe ganz die Folge systematischer Faktoren ist Die verbesserten Korrelationskoeffizienten zwischen Gruppen fur die Fehlerverteilung der ersten Probe erstrecken sich von +0,90 bis +1,00 Diese Korrelationen weisen darauf hin, dass die Fehlerverteilung fur Probe 1 ganz durch systematische Faktoren bestimmt ist, die den Gruppen gemeinsam sind Die Zuverlassigkeitskoeffizienten fur Proben 2-11 sind alle grosser als +0,97 Die verbesserten Korrelationskoeffizienten zwischen den Gruppen fur die Fehlerverteilung der Proben 2-11 erstrecken sich von +0,95 bis +0,99 Da die Korrelationen zwischen den Belohnungsgruppen und den Gruppen ohne Belohnung +0,98 und +0,99 sind, wird gefolgert, dass die relativ Schwierigkeit der blinden Gänge nicht durch die allgemeine Futterorientierung bestimmt ist. Die Zwischenkorrelationen zwischen den Gruppen fur Proben 2-11 deuten auch an, dass Differenzen in dem Antrieb Differenzen in der relativen Schwierigkeit der blinden Gange nicht verursachen

BALLACHEY UND BUEL

GENERALIZATION AND SPECIFICITY OF THE PLANTAR RESPONSE IN NEWBORN INFANTS. THE REFLEXOGENOUS ZONE. III THE EFFECTS OF THE PHYSIOLOGICAL STATE UPON SENSITIVITY, SEGMENTAL PARTICIPATION, AND SEGMENTAL PATTERNING*[1]

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INTRODUCTION

The developmental history of vertebrates is characterized by an initial embryological stage during which stimulation elicits responses directly from the muscles This activity must necessarily be limited in scope since correlational mechanisms which would permit an irradiation of response are lacking at this time Such a developmental period has been demonstrated by Angulo y González (2) in the albino rat and by Minkowski (18, 19) in the human fetus.

This stage is followed by one in which activity may arise either directly through stimulation of the muscles or indirectly through neural innervation Finally the nervous system becomes the dominant intermediary in the arousal of activity.

It has been demonstrated by Coghill (7, 8) and others that in subhuman vertebrates the initial responses (excluding the myogenic) of the organism or of some major segment thereof are generalized, in that the first movements of the parts occur only in conjunction with the larger segments (within the "total pattern"). Subsequent development provides an individuation of segmental movement whereby specific part activities may appear independently. The axial trends of this individuation are the proximo-distal and the cephalo-caudal In human infants Irwin (11, 13), Shirley

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(28), and Marquis (17), as well as earlier writers such as Buck (6), have noted the same trend.

Similarly, study of reflexogenous zones indicates that the effective areas of stimulation are at first extensive, and then become progressively restricted as far as stimuli of normal intensity are concerned. Coghill (8) has found this in lower animal forms and Minkowski (18), Bersot (5), and Pratt, Nelson and Sun (27) have provided evidence of this developmental change in neonates

The requisite condition for the appearance of specific activity has been defined by Coghill as the "inhibition of the total pattern." Basically this condition must be achieved, as Peiper (20, 21) has noted, through developmental agencies. Secondarily, the condition becomes dependent upon the effect that different stimulating factors exert upon the developed activity mechanisms of the organism

The writer has held (22, 24) that certain internal and external forms of stimulation, acting upon the neonate, tend to bring into play almost all of the mechanisms which have thus far developed, and hence produce a generalized activity of maximum and persistent character. This is Irwin's "mass behavior" (11, 14). He errs, we believe, in terming this the matrix from which specific behavior emerges. An analysis of neonate behavior seems to indicate that such "mass behavior" is not a fundamental *developmental stage* but only a *particular instance* of generalized activity

Obviously a state of this kind is not favorable for the arousal of limited, localized responses The history of neonate study offers eloquent testimony of this, in that relatively quiescent infants have been selected for practically all observations. This means that infants are selected according to their condition with reference to nursing periods and other changes in order to exclude the potent internal or external stimulating factors just mentioned. In fact, only those who have been engaged in quantitative study of general activity, such as Benedict and Talbot (4), Eckstein and Paffrath (10), Pratt, Nelson and Sun (27), and Irwin (11, 12), have attempted to consider the infant's activities in relation to the existing physiological states.

There are, however, a few dominant types of stimuli which succeed, temporarily at least, in inhibiting that continued generalized activity which Irwin and others have termed "mass behavior." Examples of such in ascending order of effectiveness are. audi-

tory, static (swinging, rocking, etc.), contact and kinaesthetic (sucking, restraint of arm movements, etc.) Jensen's (15) investigation of the sucking response has demonstrated the quick abolishment of the "mass behavior." The effects of sucking, deglution, etc., in reducing or abolishing the generalized responses involving the skeletal muscles have been observed by Tilney and Casamajor (31) in nursing kittens. Apparently such inhibition applies only to skeletal activity, for Baliassnikowa and Model (3) find increased activity in those parts of the human infant which are regulated by the autonomic nervous system.

As has been suggested by Bersot (5) and by Angulo y González (1), the earlier generalized pattern does not disappear completely and permanently in the course of development. We have just noted that after the infant has attained a stage of development which permits *localized specific responses*, certain stimulating conditions such as internal stimuli acting along the alimentary canal or external stimuli of thermal or noxious type evoke a generalized activity *which is characterized by its extent and persistence.* Bersot (5) has claimed that by increasing the intensity of stimuli applied to adults it is possible to re-establish the infantile generalization of the plantar response. Emotional states in older individuals likewise point to the latent total pattern, as do pathological phenomena and those induced by drugs. Furthermore, in learning, the individual *passes through initially generalized stages before he attains adjustments* which are more specific. Coghill (8) has called attention to this, and the work of Steinmann (29) furnishes confirmation of this upon the human level.

If certain dominant stimuli may temporarily inhibit continuous *generalized activity, one may well inquire into the consequences of* stimuli which are not so effective. Why have investigators found it necessary to deal with a quiescent organism in order to determine the effects of external stimuli? The answer seems to be that otherwise there would be so much activity that none of it could be singled out as causally identified with the stimuli which were given. What, then, are the effects of external stimuli upon an organism with heightened irritability which has not progressed to the point of continuous activity? The writer (23) has demonstrated that auditory stimuli, distributed over a period of increased motility such as we have specified, produce activity which is superimposed upon

the existing base. Isolated auditory stimuli at times may cause temporary inhibition of activity already in progress For these reasons a better clue to the effect of temporary physiological conditions upon the character of responses may be obtained by using stimuli which have little dominant effect upon the organism, stimuli such as those used in evoking the plantar and allied responses.

The Problem

The aim of this paper is to investigate the effects of certain physiological states upon the responses to stimulation of the plantar and associated cutaneous areas. This is accomplished by examining (1) the sensitivity, (2) the segmental spread, and (3) the segmental patterning of responses under the nursery conditions *dry* and *asleep* as contrasted with the same indices under the conditions of *wet* or *awake*.

Technique

The methods employed in this research have been presented in detail in an earlier paper (25).

Results

In the investigations of the plantar response in 55 infants aged 1-21 days, records were kept of certain nursery conditions and other factors which, in a crude way, may determine certain physiological states. The nursery conditions recorded were those indicated as *dry* and *wet*, such determinations being made at six different times during the experimental period. Similarly, the protocals reveal the notations *awake* and *asleep*, these terms being used as previously defined with reference to neonates by Pratt, Nelson and Sun (27).

The infants selected in the nursery were those that showed no evidence of general activity at the time. When taken to the experimental room all were comparatively inactive. During the experimentation various bodily (vegetative) functions occurred (for example: micturition, defecation), and in some instances these were followed by such continuous and intense activity that the experimentation was discontinued.

In view of the selection with reference to recency of feeding time it seems probable that few, if any, of the infants were then

influenced by what Taylor (30) has called the "hunger contractions" of the stomach But there were indications that activity localized elsewhere along the alimentary tract did furnish effective interoceptive stimuli Examples of such activity are regurgitation, hiccuping (the latter not represented in this report), excretory activity involving defecation, micturition, and similar changes Any of these is capable of arousing general activity for a period of time If the infant is relatively exposed, general activity again ensues when evaporation begins to provide thermal stimuli This activity persists until the infant's clothing is changed Under the nursery conditions in the bassinet, evaporation does not have an opportunity to chill the infant, and hence no intense and continued activity occurs until the gastric component comes into play When this happens, the baby's movements loosen or throw off the coverlets, evaporation starts, the maximum activity is observed soon afterward

A precise technique for the recording of these physiological functions would facilitate the study of activity under the varying physiological states. It must be stressed that with such relatively crude methods we were unable to obtain sharp lines of demarcation and therefore undoubtedly have not succeeded in dividing our data into strictly homogeneous groups This operates to reduce the group differences in activity which, with better control, should be much response in experiments wherein all parts of the experimental program were successfully completed In this study are included the more clear cut

The two preceding papers have dealt with aspects of the plantar results of experiments which had to be discontinued (a relatively small number) because of the intense activity and crying that followed the physiological functions just discussed The results of stimulation prior to discontinuance of the experiment are tabulated in the *wet* or *awake* group.

We have raised the question regarding the effect of a state of high irritability upon the nature of particular responses, for instance its possible effect upon our indices of sensitivity and segmental participation Is sensitivity (percentage of response to stimulation) decreased or increased under these conditions? Is the response more localized or does it spread over more segmental elements? Partial answers to these questions are to be obtained from the results of this experiment

TABLE 1

SENSITIVITY AND SEGMENTAL PARTICIPATION ACCORDING TO THE NURSERY OR PHYSIOLOGICAL CONDITION AND THE AREA OF STIMULATION

Areas of stimulation	No S	Dry and asleep No R	% R	Mean	P E.	Wet or awake No S	No. R	% R	Mean	P.E	Diff of m's	PE_{diff}	Diff / PE_{diff}
Rt. plant. med.	163	159	97 5	6 49	19	51	46	90.2	6 05	32	.44	.37	1.18
L plant. med.	158	150	94.9	6 30	19	54	50	92 6	6 04	38	26	42	61
Rt. plant. mes b.	151	134	88 7	5.29	.19	67	59	88 0	6 22	.34	93	38	2.44
Rt. plant. lat b	163	147	90.2	5.91	19	52	48	92 3	6 34	32	43	37	1 16
Rt. hal. plant. s	165	111	67 3	3 02	.13	48	36	75.0	4 14	31	1 12	.33	3 39
Rt. pedes dorsum	169	87	51 5	5 60	.27	47	37	78 7	6 23	39	63	47	1 34
Rt T2 plant. s	150	73	40.9	3.89	.23	68	30	44 1	4 84	43	95	48	1 98
Rt. tend Ach ins	152	70	46 0	5 18	27	69	28	40 6	6 03	40	85	48	1 77
Rt. T5 dorsum	165	66	40 0	4 57	24	52	27	51 9	5 20	40	63	46	1 37
Rt. leg mes s	165	70	42.4	3 62	.22	46	21	45 6	6 27	.58	2 65	62	4.27
Rt. hal dorsum	153	67	43 8	4 49	.25	66	29	43 9	3 77	.33	72	41	1 75
Rt. T5 plant. s	150	65	43.3	4 80	.26	67	22	32 8	4 68	40	.12	47	25
Rt. T2 dorsum	164	62	37 8	3.42	19	45	21	46 7	4 46	36	1 04	40	2 60
Totals	2068	1261	60 9	5 08	.06	732	454	62 0	5 56	11	48	.12	4 00

Legend Rt. plant. med, right plantar median line; L. plant. med, left plantar median line, plant. mes b, plantar mesial border, plant. lat. b, plantar lateral border, hal plant s, hallux plantar surface, pedes dorsum, top of foot; T2 plant s, T2 plantar surface, tend Ach. ins, insertion of tendon of Achilles, T5 dorsum, top of T5; leg mes s, mesial surface of leg at knee; hal dorsum, top of hallux; T5 plant. s, T5 plantar surface; T2 dorsum, top of T2.

S, stimuli

R, responses

P E, probable error

Diff of m's, difference of means

PE_{diff}, probable error of the difference

$\dfrac{\text{Diff.}}{PE_{diff}}$ difference of the means divided by the probable error of the difference

The Effect of Nursery or Physiological Conditions upon Sensitivity and upon the Segmental Participation in the Response Analysis of Table 1

1. When all areas are considered in the *wet* or *awake* condition, there is an increase of 48 in the average of segmental movements per response as compared with the *dry* and *asleep* condition. This is a statistically significant difference, since Diff of m's/P.E $_{diff}$ =4.00

2. Four areas, the *Rt plant med*, *L. plant med*, *hallux dorsum* and *T5 plant s*, manifest a statistically insignificant increase in the degree of segmental spread under the *dry* and *asleep* condition

3. Among the individual areas the most significant differences between the responses under the physiological categories are found in connection with stimulation of the *hallux plantar surface* and the *leg mesial surface* For the first area, the difference between the means of the two physiological complexes is 1 12 (Diff of m's/P E.$_{diff}$ =3.39). For the latter the difference is 2.65 (Diff. of m's/P E $_{diff}$ =4.27).

4. When all areas are considered, there is a slightly greater sensitivity in the *wet* or *awake* condition than when the infant is *dry* and *asleep* In the former condition the percentage of response is 62.02 and in the latter 60.97. It is extremely doubtful whether this small difference can have any significance.

The effect of different physiological states upon the respective numbers of response patterns cannot be ascertained definitely in the present study, because we have about three times as many cases in the *dry* and *asleep* group as in the *wet* or *awake* group. Nevertheless, an inkling as to the nature of such effects is provided by study of Table 2

The Number of Responses per Response Pattern according to the Physiological or Nursery Condition Analysis of Table 2

1. The greatest concentration of responses in the *dry* and *asleep* group, 4 11 responses per pattern, is obtained upon stimulation of the *hal. plant s* and the least, 2 48, upon stimulation of the *hal. dorsum*.

2 In the *wet* or *awake* group the greatest number of responses per pattern is 2 23 for the *hal. dorsum*, and the least 1.10 for the *leg mes. s*

TABLE 2

THE DISTRIBUTION OF RESPONSES AND RESPONSE PATTERNS UNDER DIFFERENT PHYSIOLOGICAL OR NURSERY CONDITIONS

Areas of stimulation	Dry and asleep No R P's	f	f/R P	Wet or awake No R P's	f	f/R.P.
Rt plant. med	40	159	3 97	27	46	1 70
L plant. med	39	150	3 84	34	50	1 47
Rt plant mes. b	37	134	3 62	31	59	1.90
Rt. plant lat b	38	147	3 86	29	48	1 65
Rt hal plant s	27	111	4 11	26	36	1 38
Rt pedes dorsum	27	87	3 22	22	37	1.68
Rt T2 plant s	21	73	3 47	20	30	1.50
Rt tend Ach ins	23	70	3 04	18	28	1 55
Rt T5 dorsum	22	66	3 00	15	27	1.80
Rt. leg mes. s	24	70	2 91	19	21	1.10
Rt hal dorsum	27	67	2 48	13	29	2.23
Rt T5 plant. s.	22	65	2.95	16	22	1 37
Rt T2 dorsum	18	62	3.44	14	21	1 50

Legend No R P's, number of response patterns
f, number of responses
f/R P., ratio of responses to response patterns

3 It seems unlikely that the difference in the size of the ratios for the two physiological categories is attributable to the difference in size of the respective samples For example, in the case of the *hal plant. s*, if the same ratio of responses to response patterns prevailed in the *wet* or *awake* condition as is found in the *dry* and *asleep* group, there would be about 8 patterns But we actually find 26 patterns—only one less than the *dry* and *asleep* group. Hence under the *wet* or *awake* condition behavior must be more variable

It has been shown by Bersot (5) and by Lantuejoul and Hartmann (16) that the earliest postnatal movements of the toes in response to plantar stimulation are movements of flexion The percentage of movements of extension increases as the days pass The infants upon whom the present study is based were, with few exceptions, at the developmental period when toe extensions predominate.

Summing up, for all infants and all areas it was found (25) that about two-thirds of toe movements consist of extension If the physiological conditions which we are considering tend to produce the ontogenetically older responses we should expect relatively

more movements of extension under the condition *dry* and *asleep*[2] than under the conditions *wet* or *awake.* Only tentative answers are to be derived from a consideration of the data in Table 3.

The Effects of Physiological Conditions upon the Character of Toe Movements: Analysis of Table 3

TABLE 3

THE RELATIVE PROPORTION OF MOVEMENTS OF EXTENSION IN TOE RESPONSES UNDER DIFFERENT PHYSIOLOGICAL AND NURSERY CONDITIONS

Areas of stimulation		Dry and asleep T M	%	Wet or awake T M	%
Rt plant. med	x	445	68 8	90	49 7
	fl	191		91	
L plant med	x	402	68 3	114	63 6
	fl	176		65	
Rt plant mes b.	x	288	70.3	137	68.4
	fl	121		63	
Rt plant lat. b	x	439	88 3	138	82 2
	fl	58		30	
Rt hal plant. s.	x	125	53 2	53	50 0
	fl	110		53	
Rt pedes dorsum	x	232	78.9	113	80.0
	fl	62		28	
Rt T2 plant s.	x	141	70 5	49	62 0
	fl	59		30	
Rt tend. Ach ins	x	182	90 0	95	95 0
	fl	20		5	
Rt T5 dorsum	x	151	79 0	88	91 6
	fl	40		8	
Rt. leg mes s	x	88	77 8	42	61 7
	fl	25		26	
Rt hal dorsum	x	134	69 3	57	76 0
	fl	62		18	
Rt T5 plant s	x	138	73 8	65	98 0
	fl	49		1	
Rt T2 dorsum	x	110	82 1	43	67 2
	fl	24		21	
Totals		All 3872		All 1523	
		x 2875	74 2	x 1084	71 1

Legend T M, toe movements
x, extension
fl, flexion

[2]It is improbable that the term *asleep* has the same significance as when applied to adults In the latter, sleep may bring about a reversion to infantile types of responses Usually this is ascribed to an abeyance of control on the part of the higher centers If Peiper (21) is correct regarding the neurology of the neonate such changes do not occur in newborn infants In children up to the age of 12 years a reversion to toe extension occurs in sleep, according to Collier (9)

1. Extension comprises 74% of toe movements in the *dry* and *asleep* state and 71% in the *wet* or *awake* state

2. For the *Rt plant med.* the respective values are 68.8% and 49 7%.

3 For the *hal plant. s* the respective values are 53.2% and 50%.

4. Five areas· *pedes dorsum, tend Ach. ins, T5 dorsum, hal. dorsum, and T5 plant. s.* show a higher proportion of movements of extension in the *wet* or *awake* state.

With the relatively crude methods used for the differentiation of physiological states, it is not surprising that only one index (number of segmental movements per response) furnishes a statistically reliable difference in behavior under the two complex conditions studied. This is in striking contrast to the differences in segmental participation between areas under the *dry* and *asleep* condition presented in Table 4.

TABLE 4

DIFFERENCES IN SEGMENTAL PARTICIPATION BETWEEN AREAS OF STIMULATION UNDER THE CONDITIONS *Asleep* AND *Dry*

Areas	Diff of m's	PE_{diff}	$\frac{Diff}{PE_{diff}}$
Rt plant. med and L. plant med.	19	.26	.73
Rt plant med and Rt plant mes. b	1.20	26	4 61
Rt plant med and Rt. plant lat b	.58	26	2 23
Rt plant med. and Rt. pedes dorsum	89	33	2 69
Rt plant med and Rt. tend. Ach ins	1 31	33	3.96
Rt plant med. and Rt. leg mes s.	2.87	.29	9 89
Rt plant. med and Rt. hal. plant s.	3 47	23	15 08
Rt. plant. med. and Rt T5 plant s.	1 69	.32	5.28
Rt plant. mes b and Rt. plant lat b	62	26	2 38
Rt. pedes dorsum and Rt. tend Ach ins	.42	.38	1 10
Rt leg mes s and Rt tend. Ach. ins.	1 56	34	4 58
Rt. pedes dorsum and Rt. hal. plant s.	2.58	.29	8.89
Rt. tend Ach. ins. and Rt hal plant s.	2 16	29	7.44
Rt leg mes. s and Rt hal plant s	60	25	2 40
Rt. T2 plant. s and Rt. hal. plant s	87	26	3.34
Rt. T5 plant s and Rt hal plant. s	1.78	.29	6 13
Rt hal. dorsum and Rt. hal. plant. s	1 47	.28	5 25
Rt. T2 plant. s and Rt. T5 plant. s	91	.34	2.67
Rt T2 plant. s and Rt T2 dorsum	.47	29	1 62
Rt. T5 plant s and Rt T5 dorsum	23	35	.65
Rt. hal dorsum and Rt T2 dorsum	1.07	31	3.45
Rt hal dorsum and Rt. T5 dorsum	08	.34	23
Rt. T2 dorsum and Rt. T5 dorsum	1.15	.30	3.83

Differences in Segmental Participation Between Areas of Stimulation under the Dry and Asleep Condition: Analysis of Table 4.

1. Considered in terms of segmental participation, the differences in response to stimulation of different areas are greater than are inter-areal differences contingent upon the physiological conditions

2. Stimulation of different areas of the plantar surface does not result in equal involvement of the effectors The difference between the means of the *mesial border* or margin and the *plantar median line* is 1.20, and this is 4 61 times the P.E. of the difference. A difference between the *median plantar line* and the *lateral border* is also noted but it is not statistically reliable.

3. As we ascend the leg, the extent of segmental participation to stimulation of cutaneous areas decreases. *Pedes dorsum* is most like the *plantar median line*, with a statistically insignificant difference of 89; *tend. Ach. ins* with a difference of 1.31 (Diff. of m's/P E $_{diff}$ =3 96), and *leg mes s* departs 2 87 from the mean of the *plant. med line* (Diff. of m's/P E $_{diff}$ =9 89).

4. The *hal plant s* departs from the *plant. med. line* by 3.47, which is 15 08 times the P.E of the difference

5. *T2* is removed from the *median plantar line* by only 1.69, and our index of reliability is 5 28.

6 The difference between the means of *hal. plant s* and *T2 plant. s.* is 0 87, which is 3.34 times the P.E. of the difference.

7. The difference between the means of *hal plant. s* and *T5 plant. s* is 1.78, which is 6 13 times the P E $_{diff}$

If the relative extent of segmental participation varies under the physiological conditions reported in this paper it is obvious that there must be also a shift in the relative frequency of occurrence of certain *patterns* of response It is obvious that responses involving the majority or all of the toes must be relatively increased under the condition *awake* or *wet*, while single segment responses are reduced in numbers

Discussion and Summary

1 *Sensitivity and the Physiological State*

The nature of the physiological state The physiological states considered in this study have been crudely distinguished in two categories (1) *dry* and *asleep*, and (2) *wet* or *awake*. In this

manner a condition of relatively little general activity is differentiated from one in which there is considerable activity, although the latter state may be the result of a number of factors acting singly or conjointly Some of these are internal and probably result from activity along the digestive tract, although the arrangement of experimentation periods in this research should reduce this factor to a minimum Other internal stimuli are furnished by excretory activities Observation indicates a short period of general activity preceding micturation or defecation, with quiescence following the act. Activity again ensues when evaporation produces thermal or external stimulation. In this selection of infants the latter factor is undoubtedly most potent in the production of general activity, but obviously this is neither as intense nor as continuous as that elicited by a combination of internal and external stimuli, such as occurs prior to the nursing period. When general activity attains its climax, responses identifiable with stimulation of the plantar areas become impossible.

The nature of sensitivity In this paper we have employed the *"percentage response to stimulation"* as the index of sensitivity in the cutaneous areas which were investigated. According to this index, that area is most sensitive which has the highest per cent R and that least sensitive which has the lowest per cent R

Theoretical considerations and the experimental results. Theoretically a physiological condition characterized by general activity should also manifest a heightened irritability which tends to approximate ordinarily less sensitive areas to those usually highly sensitive In general, sensitivity should be lower in the *asleep* and *dry* category.

The experimental findings are suggestive but too variable to be conclusive When all areas are considered (Table 1) the *wet* or *awake* conditions present a sensitivity of 62.02% while the *dry* and *asleep* value is 60 97% The *hallux plantar surface* shows a marked increase in sensitivity in the *wet* or *awake* state (75%) as compared to the *dry* and *asleep* condition (67 27%) Similarly the respective values for stimulation of *pedes dorsum* are 78 72% and 51.47%. For the most part the sensitivity differences in the two conditions for the other cutaneous areas are slight, and in some instances the change is negative rather than positive, e.g., *Rt plant med* 97 54% in the *dry* and *asleep* condition, 90 19% in the *wet* or *awake* condition.

It would appear, however, that the relative variations in the sensitivity of different areas are not appreciably altered by the physiological conditions which have been considered in this research. Since other phases (such as segmental involvement) of the response are appreciably influenced, it seems that there must be slight or no significant effect upon sensitivity—certainly the results are not what one might reasonably have anticipated.

2 *Segmental Participation and the Physiological State*

The nature of segmental participation. By segmental participation is meant the average number of segmental movements in the response of the inferior extremity. If there is a temporary regression to more generalized forms of response under the conditions *wet* or *awake,* this index should then rise, because the number of responses with limited segmental involvement should decrease in that condition

But it is apparent that the possibility of increased segmental movements is not the same for all the cutaneous areas Those which are ordinarily most generalized, such as the plantar areas, approach the maximum in segmental representation[8] and are not likely to become much more generalized under the conditions *wet* or *awake* In contrast, those areas whose stimulation usually releases the most localized responses should now manifest a considerable increase in the generalization of responses

Effects of the physiological condition. When the responses to stimulation of all thirteen areas under the condition *dry* and *asleep* are considered (Table 1) we obtain 5.08 as the mean of segmental movements in a response; but under the conditions *wet* or *awake* the mean is 5 56, an increase of 0.48, which is statistically reliable (Diff. of M's/P E_{diff} =4 00) It is therefore practically certain that in some physiological states there is a reversion to more generalized forms of the plantar response

If the response differential for individual areas is now examined, it is evident that the plantar and other areas that give the highest degree of segmental involvement under the *asleep* and *dry* condition manifest the least increase in segmental participation when the condition changes to *wet* or *awake* But those, such as the *hal plant.*

[8]Each segment may be represented in the response by flexion or extension, or by both of these in succession In addition a third movement, fanning, may occur in the toes

s. and the *leg mes. s.*, which show the greatest individuation or limitation of response when the infant is *dry* and *asleep*, have the greatest increase in segmental spread when the child is *awake* or *wet*.

Statistical reliability of differences, between areas that are under the same physiological condition, in segmental participation. The effectiveness of the temporary physiological state in altering the degree of specificity of a response is strikingly less than that of the factors which operate to set up differences between various cutaneous areas of the limb (Table 4) in their segmental participation. When stimulation of plantar areas is contrasted with stimulation of the *hal plant s* and the *leg mes s*, as to the number of segmental movements per response, the differences are found to be large and statistically reliable. We have already demonstrated (25) the existence of such differences in our analysis of the total data wherein we ignored the physiological or nursery conditions. From what has been advanced in this paper it is seen that when the infant is *dry* and *asleep* conditions are most favorable to the production of the most specific responses, which are mediated through a given receptor surface. The difference between the means of the *Rt plant. med.* and the *hal. plant. s.* is 3.47 (Diff. of $M's/P\,E_{diff}=15.08$); between the *Rt plant. med.* and *leg mes s.* 2.87 (Diff of $M's/P\,E_{diff}=9.89$) Similarly the difference between the *hal. plant s* and *T5 plant s* is 1.78 with the Diff. of the $M's/P\,E_{diff}$ being 6.13. Hence the utilization of the index of segmental participation in the exploration of reflexogenous zones receives statistical sanction.

3. *The Effects of the Physiological State Upon the Segmental Patterning of Responses.*

Number of segmental movements The patterning of a response depends upon the number of segments participating in it, and upon the character of the segmental movements If a given physiological condition increases the average number of movements per response, it follows that a shift in patterning has occurred through which the limited segmental responses are diminished and the more extensive segmental responses are increased.

Character of the segmental movements Other investigators such as Bersot (5) and Lantuejoul and Hartmann (16) have affirmed the ontogenetic primacy of plantar flexion of the toes, and Collier (9) has reported that during sleep there is a regression from

the adult form of plantar flexion to toe extension We might infer that at this labile transitory stage there is a similar regression from toe extension to toe flexion under the conditions *awake* or *wet*

If conclusions were to be based solely upon the changes that occur in the character of the response in consequence of stimulation of that traditional area—the median plantar line—one would consider such a reversion plausible (*dry* and *asleep*—68 8% toe extension; *wet* or *awake*—49 7% toe extension). The variability (Table 3) in the direction of the shift among the different areas is thus so great that in terms of totals for all areas there is 74 2% extension for *dry* and *asleep* and 71.1% for *wet* or *awake.* Further experimentation will be required in order to solve this special problem.

The variability in patterning In the second paper (26) of this series it was shown that areas vary in the number of response patterns which are elicitable, and in the relative frequency with which given response patterns occur The unequal sampling here in the two physiological categories makes it impossible to ascertain directly the effects of such conditions upon the relative *number* of patterns Indirectly, from the ratio of responses to patterns (Table 2) it may be inferred that patterning is more variable under the conditions *wet* or *awake.* This is to be observed for all areas, but it is particularly conspicuous when the *hallux plantar surface* is stimulated Through that area 36 responses distributed over 26 patterns (ratio=1 38) were obtained, whereas under the *dry* and *asleep* state there were 111 responses which were scattered over 27 response patterns. To have preserved the same proportion there should have been only about 8 response patterns in the former physiological state.

Conclusions

1 *Sensitivity and the Physiological State.* Sensitivity, as expressed by the percentage of response to stimulation of cutaneous areas of the inferior extremity, is only slightly, if indeed at all, affected by the conditions considered in this study

2. *Segmental Participation and the Physiological State*

a. Under the conditions *wet* or *awake* as contrasted with *asleep* and *dry* there is a regression to a more generalized segmental participation in the response.

b. Areas which release the most specific responses under the optimum condition of *asleep* and *dry* manifest the greatest increase in the number of segmental movements per response when the infants are *awake* or *wet*

c The differences between certain areas in the extent of segmental participation in activities which may be aroused are greater than those observed for a given area under the two physiological classifications

3 *The Effects of the Physiological State Upon the Segmental Patterning of Responses.*

a Under the *wet* or *awake* conditions the patterns that involve relatively greater segmental participation increase in frequency of occurrence.

b. It is uncertain whether there is a regression from extension to flexion in the character of toe movements

c It is apparent that the number of response patterns is relatively greater in the *awake* or *wet* than in the *asleep* and *dry* state.

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LA GÉNÉRALISATION ET LA SPÉCIFICITÉ DE LA RÉPONSE PLANTAIRE CHEZ LES NOUVEAU-NÉS. LA ZONE RÉFLEXOGENE III LES EFFETS DE L'ÉTAT PHYSIOLOGIQUE SUR LA SENSITIVITÉ, LA PARTICIPATION SEGMENTAIRE ET LA CONFIGURATION SEGMENTAIRE

(Resumé)

L'auteur a étudié les effets des états physiologiques, représentés par les catégories *Sec* et *Endormi* et *Mouillé* ou *Eveillé,* sur les réponses plantaires chez 55 nouveau-nés âgés de 1 a 21 jours On a stimulé treize aires cutanées (y compris la ligne plantaire mediane) de l'extrémité inferieure au moyen d'un contact caressant avec le contrôle partiel des facteurs de pression et de temps. On a observé huit segments pour le caractere du mouvement, la participation ou la non-participation dans la réponse

Les états physiologiques compris dans cette étude ont tres peu d'effet sur la sensitivité des diverses aires cutanées

Dans les conditions *Mouillé* ou *Eveillé,* contrastées avec *Endormi* et *Sec,* il y a eu une régression à une participation segmentaire plus généralisée dans la réponse La plus grande augmentation a eu lieu quand on a stimulé les aires qui ont causé les réponses les plus specifiques dans la catégorie *Endormi* et *Sec* Les différences entre les aires dans la participation segmentaire ont été, pour la plupart, plus grandes que les différences dans les états physiologiquement différents pour les mêmes aires

Il s'est montré une plus grande variabilité dans les formes des réponses et une augmentation de celles où il s'agit d'une participation segmentaire relativement plus grande dans les conditions *Mouillé* ou *Eveillé*

PRATT

VERBREITUNG UND SPEZIFIZITAT DES FUSSSOHLENREFLEXES BEI NEUGEBORENEN KINDERN DIE REFLEXOGENE ZONE III. DIE WIRKUNGEN DES PHYSIOLOGISCHEN ZUSTANDS AUF EMPFINDLICHKEIT, SEGMENTALTEILNAHME UND SEGMENTALGESTALTUNG

(Referat)

Der Autor untersuchte die Wirkungen der physiologischen Zustände, wie die Kategorien von *trocken* und *Schlaf* und *nass* oder *wach,* auf die Fusssohlenreflexe bei 55 neugeborenen Kindern von 1 bis 21 Tagen alt Dreizehn Hautflachen (einschliesslich der Fussohlenmittellinie) des Untergliedmasses wurden durch einen Streichkontakt mit Teilkontrolle des Druckes und der zeitlichen Faktoren gereizt. Acht Segmente wurden

bezuglich der Natur der Bewegung, Teilnahme oder Nichtteilnahme an der Reaktion beobachtet.

Die physiologischen Zustande, die dieser Untersuchung zugrunde liegen, haben wenig Wirkung auf die Empfindlichkeit der verschiedenen Hautflachen

Unter den Umstanden von *nass* oder *wach* im Gegesatz zu *Schlaf* und *trocken* fand eine Ruckkehr zu einer verbreiteteren Segmentalteilnahme der Reaktion statt Die grosste Zunahme kam auf Reizung derjenigen Flachen vor, die die spezifischsten Reaktionen in der Kategorie von *Schlaf* und *trocken* freigab Flachenunterschiede in Segmentalteilnahme waren zum grossen Teil grosser als die Unterschiede unter physiologisch verschiedenen Zustanden fur dieselben Flachen

Es gab eine grossere Variabilitat der Reaktionsgestaltungen und eine Zunahme in denjenigen, die relativ grossere Segmentalteilnahme unter den Zustanden von *nass* oder *wach* zur Folge hatten

PRATT

A QUANTITATIVE CLINICAL METHOD OF RECORDING THE SOCIAL BEHAVIOR OF YOUNG CHILDREN*

From the Clinic of Child Development, Yale University

RUTH W. WASHBURN AND JOSEPHINE R. HILGARD

Each year a considerable number of children between the ages of 15 months and 4½ years are referred for study to the clinical psychological service at the Clinic of Child Development, Yale University. While the interview with the parent or guardian is carried on the child (if sufficiently independent of his attendant and free from infection) is given an opportunity to play in the nursery with a group of 6 or 8 children of nursery-school age who are to be found there each day. We were convinced that our impression of a given child would be much more precise if his social behavior during free-play periods while with this group could be more quantitatively recorded than it is in the diary type of record A former study (2) showed that records of the spontaneous social behavior of young children can be kept in such a way as to make concrete intercomparison possible. Though the nursery cannot be considered an experimentally controlled social situation, the activities of the children in the Nursery Group during free-play periods are sufficiently uniform to permit deduction and comparison. The two hypotheses formulated in the earlier study (and more fully discussed there) must again be quoted as underlying this study First, an individual may, and commonly does, behave in a given situation in a manner fundamentally characteristic of him Secondly, a situation which is new to an individual evokes behavior just as truly indicative of his personality as a situation with which he is familiar

Our study was carried on in two different situations. One observer studied the behavior of 54 children, 18 months to 4½ years of age, on the day that they were first introduced into the Nursery Group at the Clinic of Child Development As far as practicable

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four records were made of the behavior of each child Each record was 5 minutes in length, two records were made of behavior indoors, two of behavior outdoors during free play periods. The second observer made similar records of the behavior of 22 children, divided

TABLE 1

DISTRIBUTION BY AGES OF CHILDREN STUDIED AT CLINIC OF CHILD DEVELOPMENT (CCD) AND THE PRIVATE NURSERY SCHOOL (PNS)

Age in months	18-29+	30-41	42-53	54+	Totals
Clinic group (CCD)	15	14	19	6	54
School group (Autumn PNS)	1	9	7	5	22

The children studied were all average or above with respect to intelligence (For a discussion of degree of intelligence as a factor in making social adjustments the reader is referred to the study quoted above)

into three homologous age groups (two-year-olds, three-year-olds and four-year-olds) in a private nursery school. Here one set of records was made in the autumn, one in the winter, and a third in the spring

A long step in the direction of precision was made by the use of a device contrived with the collaboration of Dr Raymond Dodge of which a preliminary description (1) has already been published. This device consists of a Becker time-marker so mounted that it can be adjusted over the left ear like the receiver of a telephone The well-defined ticking of the seconds by the time-marker can be clearly heard. As each second is ticked off a check mark is made by the observer on a sheet of paper which is held securely on a clip lapboard. A sliding ruler which moves freely across the surface of the lapboard so orients the hand that the check marks are made in a line across the page without the removal of the observer's eyes from the subject studied. The lapboard may be held across the left arm. The slide rule and the pencil are easily managed by the right hand, whether the observer is seated or standing. A stop watch held in the left hand enables the observer to measure accurately the length of time during which the child is under observation That the device enables one to account fairly accurately for each second of time is evidenced by the fact that in making 159 records, 300 seconds each, the exact number of seconds was accounted for in 17 6% of the records. From one to five seconds more or less than 300 were recorded in 50 9% of the records Six to ten seconds more or less than 300 were found in 22 6% of the records A plus or minus

deviation of more than ten seconds was found in only 8.8% of the records. The fact that a few seconds were not accounted for in 50.4% of the records may probably be explained by the recorder's delay in making judgments. The addition of a few seconds in 32% of the records is more difficult to explain. Possibly the recorder over-compensated when aware of having missed a second in making a judgment or adjustment, or there may have been a sympathetic "speeding up" with a child who moved very fast.

Given the device, we then selected and defined the aspects of behavior we wished to attempt to study. Our primary purpose was to study the nature of a child's relation to his fellows during periods of free play in Nursery Groups. After some preliminary analysis, 5 types of play involving varying degrees of social participation were defined and each one designated by an appropriate symbol as follows:

1. O, indicated that the child spent his time in observation of, without active participation in, the activities of others whether adults or children.

2. S, indicated that the child engaged in solitary play. He was engrossed in things to the exclusion of people.

3. G, was the symbol used for gregarious play. In this form of play the child tolerated the near presence of others (as for example at the sandbox or on the slide) but was essentially engrossed in his own interests within the group.

4. *P, indicated parallel play. The child might be engaged in a* project similar to that of another child, as for example, constructing something with the blocks or painting at an easel. The play could not be considered truly parallel play unless there was interchange of ideas between the children as they played, though each brought his own project to completion.

5. C, was the symbol used to indicate cooperative play, by which we understood that type of play in which two or more children joined forces to bring to completion a common project or to carry on an imaginative play to which each contributed.

In the course of the five-minute period during which a child was under observation any shift in behavior on the part of the child was indicated in the record by changing the symbol, after which the observer continued to check the seconds as described above until another shift in behavior occurred. As each five-minute record was completed the number of seconds spent by the child in the different

types of play could be counted and the percentage of the total estimated For example, a record chosen at random shows that T.S., age 3 years and 11 months, spent 21% of her time in observation of others, 6% in solitary play, 53% in parallel play, 4% in cooperative play, and the remaining 16% in activity which in the observer's judgment was not included under any of the five categories. Descriptive comment was added by the observer on each record in order that judgments might later be checked

Study of the records of the children in the private nursery school (that is in a social group to which they were accustomed, hereafter referred to as P N.S) reveals the fact that development is in the direction of the more social forms of play The records were considered in four age groupings, I, 18 to 29 months, II, 30 to 41 months, III, 42 to 53 months, IV, over 54 months From the first to the third group, the averages show a small but constant decrease (from 25.6% to 17.1%) in the amount of time spent in observation of the activities of others. The percentage of time spent in solitary play decreased from 38 6% to 9 6%, while there was a constant increase in the percentage of the time spent in parallel or cooperative play. Children from 3½ years of age characteristically spent about half their time (47 4%) in cooperative play, only 9.6% in solitary play, while Group I, spent 38.6% of the time in solitary play, and only 17.8% in cooperative play While this developmental tendency is much less clearly revealed by the records of the children making their first contact with a social group, it is still in evidence. These children in Age Group I tended to spend about an equal amount of time in observation of others and in solitary or gregarious play and there was no record of either parallel or cooperative play In Age Group III, however, the averages show 3 4% of the time spent in cooperative play, 4 9% in parallel play, even on the child's first day with a social group new to him. In both situations studied, the tendency for observation of the activities of others to decrease in amount as the children increased in age and casual experience and to be replaced by play in one or another of its forms is clearly evidenced By the time the average child, as his picture emerges from the records under the conditions of our study, was 4½ years of age we found him even when plunged into a stronge social group spending 67.5% of his time in play, solitary, gregarious, parallel, or cooperative, and only 26 3% of his time in watching others, while

a child 18 months to 2½ years of age may spend about 45% of his time in watching others and 45% in solitary and/or gregarious play. Table 2 presents these facts in the two situations The category SGPC refers to play of any type as opposed to mere observation of others

TABLE 2

Age level		18-29 months	30-41 months	42-53 months	54+ months
SGPC	CCD	45 2%	48 7%	56 3%	67 5%
	PNS	60 8%	64 3%	75 4%	72 6%
Coop.	CCD	0 0%	0 1%	3 7%	3 0%
	PNS	17 8%	18 2%	47 4%	45 0%
Par	CCD	0.0%	3 2%	4 9%	9 2%
	PNS	2 7%	11.5%	16 3%	16 2%
Gr	CCD	19 6%	25.0%	30 2%	26 7%
	PNS	9 0%	6.0%	1 7%	0 7%
Sol	CCD	24 5%	20 1%	18 4%	33 7%
	PNS	38 6%	28 8%	9 6%	9 5%
Obs	CCD	42 6%	50 1%	41 9%	26 3%
	PNS	25 6%	21 6%	17 2%	17 5%

The tendency to develop in the direction of the more social types of play is found in the records of individual children who have been observed at intervals of a year. K Q was studied when she was 2 years old and again at 3 years of age in a social group of which she was a regular member Table 3 compares the child's average distribution of time at these ages with the group averages

TABLE 3

AVERAGE DISTRIBUTION OF PLAYTIME BY K Q AT TWO AND THREE YEARS OF AGE

	Obs	Sol	Gr	Par	Coop	SGPC
K Q Age two years	37 7%	16.0%	43 7%	0 0%	0 0%	59 7%
P.N S group Averages— two years	25 6%	38 6%	9 0%	2 7%	17 8%	60 8%
K Q Age three years	20 8%	14 4%	4 2%	8 4%	31.7%	64 2%
P.N S group Averages— three years	21 6%	28 8%	6 0%	11 5%	18 2%	64 3%

Since the distribution of this child's playtime approximated the average distribution more nearly at 3 years than it did at two years,

she may be said to have developed in the direction of the more social types of play at a rate somewhat faster than the average Potentially a "sociable" child, very much interested in the other children, she was also very sensitive She appeared to need the security gained from playing near the children over a period of months before she was sufficiently "at home" to participate in the group activities to the extent of which the later studies have shown her to be capable.

This method of recording observations also differentiates succinctly behavior patterns characteristic of the child under observation. In Table 4 the records of 2 children of comparable age but very different personality types are compared with the averages for their age level

TABLE 4

AVERAGE DISTRIBUTION OF PLAYTIME BY TWO CHILDREN IN A PRIVATE NURSERY SCHOOL

	Obs	Sol	Gr	Par	Coop.	SGPC
P N S averages at 54 months +	17.5%	9 5%	0 7%	16.2%	45 0%	72.6%
T X 58 months	1 4%	9 7%	0 0%	11 9%	69 0%	90 0%
B D 59 months	21 3%	18 7%	0 0%	33 2%	1.1%	52 0%

The casual observer of the group would certainly have noticed T X Very active and talkative, he was popular with the other children and constantly participating in the group play. B.D. on the other hand might have passed unnoticed by the casual observer for some time, after which the excellence of her block house, made parallel to that of other children but very quietly and independently, might draw one's attention to her The figures above present this fact strikingly It will be noted that T X is consistently less engaged in solitary pursuits, more cooperative in the group play than the average child (as revealed by these data), while the distribution of B D.'s time brings out her tendency to remain withdrawn from the group

If one studies the records made of children on the day they first contacted the social group, one also finds great individual differences in the degree of their social participation. The two children contrasted in Table 5 were of comparable age and mental development and were as well both children who had been deprived, to a com-

TABLE 5
DIFFERING DEGREES OF SOCIAL PARTICIPATION ON CHILDREN'S FIRST CONTACT WITH A SOCIAL GROUP

	Obs	Sol.	Gr	Par	Coop	SGPC
Averages						
42-53 months	41 9%	18 4%	30 2%	4.9%	3 7%	56 3%
G.X. 52 months	24 0%	32 0%	32 0%	2.0%	10 0%	67.0%
I.I 51 months	89 0%	11.0%	0 0%	0 0%	0.0%	11 0%

parable degree, of the companionship of others of the same age, so that one was not clearly more practiced than the other in setting up relations with other children

Though G.X. spent more time than some children in carrying out his solitary interests, he was also better able at once to enter into the group play, while I.I was usually quiet, unable except for a very small percentage of the time to emerge from observation of the activities of others to carry on even individual interests.

CLINICAL STUDIES

It is hoped that this method of recording the social behavior of young children may be useful clinically, in adding concretely to the impression made by the child in the individual psychological examination. Since a child brought in to the clinic for diagnosis is often seen but once, it was important to try to discover whether the children's behavior on their first contact with the group differed markedly from their behavior on successive contacts with the group. That the group has an initial but temporary inhibiting effect on most new children is undoubtedly true. Whether this inhibiting effect is so great as to obscure the child's personality type is the question on which we tried to throw some light.

A child who was known to be capable of a high degree of social participation in the group of which she was a regular member, and who thus was not only thought to be socially outgoing but had had practice in setting up social relations in a group, was brought for study to the clinic and introduced into a social group which was new to her Table 6 contrasts her behavior in the two groups with the averages at her age level.

Though there was undoubtedly less social participation in the new situation than in the one to which she was accustomed, the child's tendency is still in the direction of the more social types of play as

TABLE 6

DISTRIBUTION OF PLAYTIME OF B N AT PRIVATE NURSERY SCHOOL AND CLINIC OF CHILD DEVELOPMENT

	Obs	Sol	Gr	Par	Coop	SGPC.
P N S. averages 54 months +	17.5%	9 5%	7%	16.2%	45 0%	72 6%
B N at P.N S age 54 months	4 2%	6 9%	0%	.9%	85 2%	93 0%
C.C D averages 54 months +	26 3%	33 7%	26 7%	9 2%	3 0%	67.5%
B N at C C.D. age 58 months	34 0%	14 0%	29 0%	23 0%	0%	66 0%

opposed to observation or solitary play. She was not sufficiently inhibited to prevent her from spending in play a percentage of her time which approximated the average If one combines the percentage of time spent in parallel and cooperative play, the child is above the averages for the group in both situations. Because the percentage of time spent in play in any one of its forms (SGPC) was 20 4% above the average for the group at the private nursery school, one might also have expected to find this percentage above the average in the new group, but this was not the case.

Moreover, we frequently had opportunity to observe on successive days a child who continued to come to the Nursery for re-education with respect to one behavior tendency or another. This again made it possible to study the restraining effect of a new social group The group studied is in a sense a selected one, as the children whom it was possible to study in this way were for the most part children brought to the clinic with minor behavior difficulties It is impossible to generalize, but four types of adjustment may be discussed.

K.Q , who was a member of the group in the nursery over a

TABLE 7

DISTRIBUTION OF PLAYTIME. K Q 23 TO 27 MONTHS OF AGE

Date	Obs	Sol	Gr	Par	Coop.	SGPC.
Jan 12	61 0%	32 0%	5 0%	0%	0 0%	37 0%
Feb. 16	31 5%	23 0%	45.5%	0%	0%	68 5%
Mar 21	61 7%	6 3%	25.3%	3 7%	0%	35 3%
Apr 7	43 7%	26 0%	30 3%	0%	0%	56 3%
May 17	47 0%	26 0%	26 0%	0%	0%	52.0%

period of months, was fairly consistent in the average distribution of her time.

Though somewhat younger than the children discussed above, K.Q. was one of the most sociable and verbal of the children in the nursery. However, the fact that only on one occasion did she engage in parallel play and never played cooperatively is additional evidence that age and experience are important factors in the development of these two forms of play Except for the fact that solitary and gregarious play shifted places in the January and March records, note the similarity in the distribution of time in these two months and again in the April and May records

TABLE 8

Distribution of Playtime: I I 51 to 52 Months

Date	Obs.	Sol.	Gr	Par.	Coop.	SGPC
Oct 25 First day	89 0%	11 0%	0	0	0	11.0%
Nov 29 Tenth day	84.0%	16 0%	0	0	0	16 0%

I.I., referred to above, also illustrates the type of child whose distribution of time was consistent even after frequent contacts with the group

Not until this child had been a member of the group for 4 months did the percentage of time spent in play of any type (SGPC) approximate the average for her age level and even then the percentage of time spent in cooperative play (16.0%) was far below the average. We should certainly have been justified in accordance with the evidence yielded by the later studies in characterizing this child as socially withdrawn after the single initial study.

The record of D S however, given in detail, illustrates quite a different type of adjustment

The records of the third day show the dramatic improvement which occurred during the morning Possibly characterization of the potentialities of this child in making social adjustments after studying him once would not have been altogether without significance, in view of the fact that he has had difficulty in making contacts with children of his own age in his public school group. He has had much companionship with adults and in general gets on better with them than he does with children. The percentage of directed

TABLE 9

ADJUSTMENT TO THE GROUP OF D S AGE 50 MONTHS

	Obs	Sol	Gr.	Par	Coop	SGPC	
First day	100 0%	0	0	0	0	0	
Second day	45 0%	0	4 5%	0	0	4 5%	Crying 40 5%
Third day	99 0%	0	1 0%	0	0	1 0%	
	59 0%	16 0%	20 0%	0	0	36 0%	
	35.0%	65 0%	0	0	0	65 0%	
	14 0%	0	69 0%	0	0	69 0%	Directed play 15 0%
Ninth day	25 0%	1 3%	48 0%	0	23 0%	73 0%	

play on the third day was high and more than the usual amount of adult assistance was given before the higher degree of social participation noted on the ninth day was possible.

The records of still a fourth child make clear the fact that we should be justified in characterizing as capable of a high degree of social participation a child whose distribution of time on the day of

TABLE 10

SOCIAL BEHAVIOR OF X.G. AGE 52 MONTHS ON INITIAL CONTACT WITH A GROUP

	Obs	Sol	Gr	Par	Coop	SGPC
Group averages						
42 to 53 months	41 9%	18 4%	30 2%	4 9%	3.7%	56 3%
First day	24 0%	32 0%	32 0%	2 0%	10 0%	76 0%
Second day	20 0%	37 0%	0	6.0%	35 0%	78.0%

his first contact with the group exceeds the averages for his age level.

This child, having moved into a neighborhood where there are many playmates, is now a popular and comfortable member of the neighborhood "gang."

Though one cannot generalize or predict the rate at which a child may become capable of a higher degree of social participation with the group, the fact that his percentage of participation is more or less than the average on his initial contact with the group certainly suggests personality differences and may be diagnostic of his manner of adjustment to later social groups.

A detailed study (by Josephine Hilgard) of a child in whose development and personality the Clinic was specially concerned is of interest as indicating the clinical uses to which this method of recording observations may be put I D. (2 years and 4 months in September) spent one morning a week with the Nursery Group, as it was thought that the stimulation of play with contemporaries might have an accelerating effect on her developmental rate More inhibited on joining the group than many children and for a longer period of time, she eventually became a highly participating member of a social group. The following figures make clear the very slow progress made during the first month:

September:	Indoors play	0		Observation	100%
	Outdoors play	51 0%	(solitary)	Observation	42%
October:	Indoors play	4 6%	(solitary)	Observation	94%
	Outdoors play	13 0%	(solitary)	Observation	87%

Before the December record I D had spent two afternoons alone in the Nursery with the adult Actual instruction was given her in the use of the playthings and while alone in this way she was active in her use of them. This experience had very little effect on her behavior when she rejoined the group

December	Indoors play	4 0% (solitary)	Observation 96%

As an experiment, on the same day that the above record was made I.D was taken alone to an adjoining room with a few toys with the following effect on her behavior while alone with the adult in this room:

Indoors play	96 0% (solitary)	Observation 3%

For several months I.D. then came in the afternoon instead of with the group in the morning. Usually one other younger child was present The following records were taken on her first regular day with the morning group. The child had been very active in her play in the afternoons Note the dramatic change that took place in the course of the morning

April—Record I	Play 0	Observation 100%
Record II	Play 0	Observation 100%

The group in attendance was small on this day and at this point children were taken from the room leaving only one younger child with I D.

Record III	Play 74% (sol 64%; Gr 10%)	Observation 24%

Following this record the 2 older children returned.

Record IV	Play 53% (solitary)	Observation 47%
Record V	Play 80% (gregarious)	Observation 20%

By the time Record V was made, instead of standing quietly watching, I.D. was in a ball game, enjoying it thoroughly, running, climbing for the ball, banging with a stick so noisily that one child said to her, "don't make that noise" Further records give a picture of active play of the solitary and gregarious types with occasional periods of lethargic observation.

A suggestion for further study is hinted at in the earliest records of the above child's behavior. Though there was no play indoors, 51% of the time outdoors was spent in solitary play Study of other records reveals the fact that the more informal outdoor atmosphere

often elicits play where there was none indoors There is apparently often less inhibition even though there are fewer playthings outdoors, perhaps due to the fact that the other children may appear more remote.

In order that a concrete impression of a child's social behavior may be available immediately, records of the above type are now made as part of the routine study of children brought to the clinic for study, are summarized as follows and incorporated in the child's individual folder:

C B 41 months		Avs—C C D 42-53 months
Obs	= 36 3%	41 9%
Sol	= 4 1%	18 4%
Gr	= 22.9%	30 2%
Par	= 4 1%	4 9%
Coop	= 26.2%	3 7%
SGPC	= 57 3%	56.3%

This child had been brought to the clinic because of "roughness" when playing with other children and inability on this account to set up satisfactory social relations (probably because of over-zealous attempts). It will be noted that the child's percentage of time spent in all forms of play very closely approximated the average but the amount of time spent in the most highly social type of play (cooperative) exceeded the average at her age level

By the use of this method of recording the undirected behavior of young children in social groups of different character, we have, then, gone a little way towards the solution of some of the questions which interest us.

We have a type of record which is capable of concrete intercomparison The fact that two observers in making simultaneous records of the behavior of a given child might not find themselves in complete agreement in the interpretation of that child's behavior from second to second must be admitted. That this is not a serious criticism against the records seems to us to be evidenced, first by the fact that the same general tendencies are shown by the records kept by two observers under very different conditions and, secondly, by the fact that the generalizations from the records made of a given child support the impression held concerning him by individuals other than the observer Two observers would certainly agree about a given child's ability to participate in social play though their percentage distribution of the child's time might differ by a few points

The fact that development in young children proceeds from the solitary in the direction of the more social types of play has, of course, many times been observed. That we have begun to plot the curve of that development enables us to appreciate the significance of the individual variations about it in terms of a given child's ability or desire to set up relations with his fellows.

Summary

Studies are in progress by means of which it is hoped to further objectify observations of the social behavior of children (15 months to 5 years of age) in nursery groups. Five degrees of participation in group activities ranging from observation of others to active co-operative enterprise were differentiated. A modification of the device reported in (1) was used. Records were made of the children's behavior for 2 periods of 5 minutes each, during both indoor and outdoor play, on their first contact with a nursery group, after a number of contacts with the group, and in groups of which they were regular members. The percentage of time spent in each type of social participation can be readily estimated from the records. The study furnishes evidence that there is development from the more individual types of play to the more social with increase of age and experience. A continuity of personality differences in adjustment to social groups is also revealed. Persistence in the more individual types of play may be attributed to a variety of factors. If inexperience is one of the major factors, continued group contacts often result in relatively fast development so that the child soon approximates the behavior characteristic of his age independent of experience. Failure to develop in the direction of the more social types of play is suggestive of fundamental personality differences.

The method is a simple one and appears to be accurate, though errors in the observer's judgment cannot be eliminated. The records can be studied quantitatively. This method of studying young children in social groups has already been clinically useful in determining the degree of social maturity as well as individual differences in ability to participate easily in group activities.

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UNE MÉTHODE QUANTITATIVE CLINIQUE DE NOTER LE COMPORTEMENT SOCIAL DES JEUNES ENFANTS

(Résumé)

Cette étude rend plus objectives les observations du comportement social des jeunes enfants En distinguant cinq degrés de participation aux activités collectives, on a fait des notations du comportement des enfants à leur premier contact avec un groupe de l'école maternelle, après nombre de contacts, et dans des groupes dont ils ont été des membres réguliers On peut estimer facilement le pourcentage du temps passé dans chaque type de participation sociale. L'étude donne des témoignages qu'il y a un développement des types les plus individuels du jeu aux plus sociaux avec l'accroît de l'âge et de l'expérience Une continuité des différences de personnalité dans l'adaptation aux groupes sociaux se montre On peut attribuer la persistance dans le type plus individuel du jeu à une variété de facteurs. Si l'inexpérience est un des facteurs principaux, les contacts collectifs continués donnent souvent comme résultat un développement relativement rapide, de sorte que l'enfant approxime les traits du comportement de son âge, indépendant de l'expérience La méthode est simple et semble être précise, bien qu'on ne puisse éliminer les erreurs dans le jugement de l'observateur. On peut étudier les notations quantitativement Cette méthode a déjà été utile cliniquement dans la détermination du degré de la maturité sociale ainsi que les différences individuelles dans l'habileté participer facilement aux activités collectives

Washburn

EINE QUANTITATIVE, KLINISCHE METHODE ZUR AUFZEICHNUNG DES SOZIALEN VERHALTENS JUNGER KINDER

(Referat)

Diese Untersuchung objektiviert weiter die Beobachtungen des sozialen Verhaltens junger Kinder. Bei der Unterscheidung von funf Graden der Teilnahme an Gruppentatigkeiten wurden Aufzeichnungen des Verhaltens der Kinder bei ihrem ersten Kontakt mit der Kinderstubengruppe gemacht, dann nach einer Anzahl von Kontakten, und in Gruppen, wo sie selbst Mitglieder waren Der Prozentsatz der Zeit, die in jeder Art von sozialer Teilnahme verbracht wurde, kann sehr leicht berechnet werden Dieses Studium gibt Evidenz an die Hand, dass ein Entwicklung der individuelleren Arten vom Spiel zu den sozialeren mit einer Zunahme des Alters und der Erfahrung stattfindet Eine Kontinuitat der Personlichkeitsunterschiede in der Anpassung an soziale Gruppen stellt sich heraus. Das Beharren in

der individuelleien Art von Spiel konnte einer Verschiedenheit der Faktoren zugeschrieben werden Wenn Unerfahrenheit einer der Hauptfaktoren ist, haben fortfahrende Gruppenkontakte oft eine relativ schnelle Entwicklung zur Folge, so dass das Kind sich den Verhaltungseigenschaften seines Alters ganz unabhangig von der Erfahrung nährt Die Methode ist einfach und scheint genau zu sein, obgleich Irrtumer des Urteils des Beobachters nicht ausgeschaltet werden konnen Die Aufzeichnungen konnen quantitativ studiert werden Diese Methode ist schon klinisch brauchbar zur Feststellung des Grades der sozialen Reife gewesen, sowie der individuellen Unterschiede in der Fähigkeit, an Gruppentätigkeiten leicht teilzunehmen

WASHBURN

THE ATTITUDES OF CHILDREN TOWARD DEATH*

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INTRODUCTION

Philosophers have tried to demonstrate that human life is lived under the aspect of death, or that human beings live under the continual threat of annihilation But if one observes human beings without preconceived ideas, one notes that while some are very much concerned about death, the majority of human beings do not give much thought to it throughout the greater portion of their lives. Superficial evidence speaks against the assumption that the attitude of the average person towards death plays any fundamental rôle in his everyday psychology

But one may raise objections against the method of naive observation and naive comparison between different human beings Modern psychology, and especially psychoanalysis, has taught us that we know comparatively little of what goes on in ourselves, and that the actions and utterances of human beings are very difficult to understand unless one investigates them systematically and with special methods. One of these is the method of systematic self-observation But experience shows that the data obtained with this method differ with different observers, and that the data are not always reliable. Husserl, taking cognizance of these difficulties, believes that the limitations of self-observation may be overcome by the use of what he calls intuitive insight (*Wesensschau*). By such intuitive insight one gets, according to this writer, immediate access into the essence of logical structures He believes that the data so obtained constitute a fundamental science, phenomenology, which he thinks goes far beyond mere careful psychological description. But we do not believe that this claim is substantiated. Husserl's phenomenology is just psychology, and as such an empirical science.

The introspective psychology of the lone observer is misleading.

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The phenomenologist must check his results with other empirical methods, otherwise he is in danger of seeing the facts of inner experience in a distorted way. The "deep" analysis of logical and psychological structures which we owe to Husserl cannot, to be sure, be subjected to this criticism. But phenomenology which presents its findings as "evidence" has not always escaped the danger of claiming evidence for mere beliefs and prejudices. The fundamental studies of Scheler are, for example, not always free from such purely subjective statements, which are proffered as absolute truths given directly by intuition.

Again Heidegger, who has used the phenomenological method in order to discover what he terms the essence of human life, states that death and absolute nothingness are constantly before the inner eye of man, and that life gets its inner meaning only by the ever-present knowledge of inevitable death. He is even of the opinion that the fact of death enables us to perceive time. He offers as proof for these assertions certain data of introspection which form the basis of his philosophical generalization. But all this is merely unverified subjective introspection. No "inner" evidence can take the place of empirical proof. If we want to know something of how human beings feel about death and what their attitude towards death is, and in what way the conception of death influences our attitude towards life, the only effective method is to make a systematic inquiry among a great many subjects. It is necessary, furthermore, to observe their reactions towards death and to record in detail what these reactions are. Furthermore, these observations must not be limited only to the reactions of adults but must include those of children as well, finally, they must include observations on individuals of different cultural strata and, if possible, on human beings of different racial origin. Again it will be necessary to employ *all* the methods of psychology, those making use of unconscious as well as conscious mental processes, before we can make any general statements. Intuition alone cannot but be an unreliable method. We must replace it with empirical observation and add to it all the methods which the psychology of the conscious and unconscious offers us.

When we observe the conscious life of an individual or limit ourselves to a study of his conscious thought processes, we observe only a small part of his total psychic life. Besides a conscious life

there is a very full and elaborate unconscious life. Freud has shown how greatly this part of psychic life influences our whole behavior. He has also shown that this unconscious life follows mental laws peculiar to itself, which are very different from those of conscious thinking. Symbolizations and condensations play an important part in it, and much of the mentation is determined by infantile strivings and desires which are ever present in the unconscious. There is a difference of opinion as to whether the unconscious is to be conceived as having an existence all it own, apart from the rest of psychic life, or as made up of experiences existing in the background of consciousness. The latter is the opinion of one of the writers According to his view, the *unconscious* of Freud differs but little from the *fringe of consciousness* as described by William James. It constitutes a special province of psychic life which he has called the "sphere"; it is in this "sphere" that he believes the germs of thought originate Whatever the nature of the unconscious may be, it is clear that there is such a phenomenon as repression which hinders psychic experiences from coming into consciousness. Psychoanalysis is a scientific method by which these experiences (unconscious thoughts) may be brought into consciousness As is familiar, it uses the method of free association in which the individual is required to say everything that goes through his mind. In this way it has been found that the stream of associations, unimpeded by logical rule or social constraint, brings to the surface and, hence into the full glare of consciousness, thoughts and wishes which have for various reasons been repressed Among these are frequently thoughts pertaining to death. From such observation it appears that persons who are consciously unconcerned with death are very frequently preoccupied with it in their unconscious life. Psychoanalysis in its earlier descriptions has in fact shown that people in general are more concerned about death than they are willing to admit Freud has always insisted, for example, that death symbolism plays an important part in dreams, and definitely proved that the unconscious contains death wishes against beloved persons, of which we are not only unaware but which we are fain to admit consciously. There is, however, no doubt that psychoanalysis is correct in its insistence that human beings are much more frequently preoccupied with thoughts of their own death as well as about that of others than they know of consciously.

In the light of the above, the question arises what meaning the word death can have in the sense of unconscious thought and what the idea of preoccupation with death may mean from a psychological point of view. Freud believes, at the present time, that there exists such a thing as a death instinct According to Freud all human beings seek to "live out" their life energies and thereby revert to the inanimate state from which life itself supposedly began. Every individual wants his own death, and, after the thermo-dynamic analogy, psychic energy is continually falling from a higher to a lower level. Freud seems to think that this death instinct does not have any psychic representation anywhere, that is, does not even appear in the unconscious Other analysts believe that there is a psychic representation of the death instinct If the death instinct as such does not appear in psychic life, its existence cannot have very much interest from a psychological point of view But Freud also identifies the wish of the individual to die with the self-destructive tendency which he calls primary masochism He believes that the libido diverts this self-destructive tendency from one's own person to that of others In this sense the death instinct and the aggressive tendencies become almost indistinguishable, although Freud still tries to maintain their separate identities. He does this by assuming that in any concrete case we are always confronted not by a simple situation but by a fusion of instincts, the fusion here being between the libidinous and the death instincts. In any case when Freud speaks about the tendency to self-destruction and the urge to destroy others, he again enters a field of psychology which he left when he posited the pure death instinct in the sense described above Nevertheless, he gives nowhere a clear description of the psychic experiences connected with the word death or of the self-destructive tendency. For him the word death merely points to the fact that life is at an end That, however, is far from the only connotation it can and does have for different people Actual investigation shows that, for different individuals, the word may have quite different connotations, and above all a variety of associations and connections which makes any single description entirely inadequate.

Human beings generally know that they have to die, but most of them actually do not seem to believe it When they think about death they generally think of it merely as a solution of their own

life problem. The idea of one's own death is connected with the hope of securing things which one otherwise couldn't obtain, or with the idea that by dying one will obtain the desired love and affection that was, until then, kept back from us. Or again, it may be a means of punishing loved ones at whose hands we have felt ourselves mistreated. People also derive pleasure from torturing themselves, and may even give up their lives in order to assure spiritual union with some cherished personality with whom they have strongly identified themselves Such, at least, are the general conclusions of Bromberg and Schilder (1), conclusions which, it should be noted, are not their own speculations or phenomenological constructions, but summarizations of introspective reports by ostensibly normal people. They were derived from descriptions of actual experiences, recorded in the responses of some 75 adult subjects to a questionnaire, supplemented by data obtained by 10 analyzed cases. This questionnaire to which we shall have occasion to refer appears at the end of this article

The paper by Bromberg and Schilder (1) is one of the first attempts at an empirical investigation of the psychology of death Schilder had previously emphasized the necessity of such an investigation and called particular attention to the fact that this problem was especially fraught with philosophical ambiguities and religious prejudices, which might perhaps be more easily avoided if the investigation were supplemented by a study of children's attitudes toward death. The following material is intended to furnish these data.[1]

Method

In looking about for a method of investigation, the use of a systematic questionnaire was the first that suggested itself Available for this purpose were the questions used by Schilder and Bromberg, but while these seemed satisfactory as a point of approach it was very soon apparent that not only their form but their content

[1]Very little can be found in the literature concerning children's attitudes toward death Piaget in his *Child's Conception of the World* (p 352) mentions that children very often believe that the dead are born again, and in his *Language and Thought of the Child* (p 178) has occasion to remark that death is a riddle to the child These and a few other isolated observations by himself and M Klein (Imago, 1929, Vol. VII) very nearly exhaust all that has been reported about children's attitudes towards death.

as well would have to be radically altered before they could be used with children. The reason for this is apparent if one examines the individual questions used by these investigators

QUESTIONNAIRE ON DEATH OR DYING

PART I

1. How often do you think about death?
2. What ideas and pictures come into your mind when you think about death?
3. Do you think about death or being dead?
4. Do you have the impression that you suppress thoughts about death?
5. Does the thought about death accompany your whole life like the base accompaniment in music which you do not want to hear?
6. Is your own death probable to you?
7. Can you picture yourself dead? How?
8. Are you afraid of death? of dying? of being dead?
9. Did you ever wish you would die or that you were dead? In what situation and why?
10. Do you ever think of suicide? What type of suicide—hanging, shooting, drowning, jumping, gas poisoning, chemical poisoning? Did you ever make any attempt to commit suicide? How did you feel before and after?
11. Do you ever think of how your relatives or persons you love would act and feel when they see you dead or hear of your death? If so, how?
12. Are your thoughts about death ever connected with an erotic situation? Do you ever bring death and love in the same connection?
13. Do you think of death during, before, or after sexual intercourse?
14. Do you believe in a life after death and how do you imagine it?
15. How do you react to the religious teachings about death and life after death?
16. Do you dread the thoughts of seeing a corpse?
17. Do you ever have fantasies of how it feels to be actually dying? What do you imagine you see and hear?
18. Did you ever imagine yourself being dead at an early age?
19. Did you ever think how you would act if you knew you were to die in a given time?
20. Do you ever think of death when you are ill? Do you think that you suffer while dying?
21. Do you ever think of being buried alive?
22. Do you think that your attitude towards death and dying has changed in the course of the years? How did you feel about it as a child? as a grown-up? Did a disease change your attitude towards death?

PART II

1. How often do you think about dying or the death of others—(*a*) father, (*b*) mother; (*c*) brothers and sisters, (*d*) husband or wife; (*e*) children, (*f*) friends, (*g*) sweetheart? Do you imagine them as dead or dying? What do you think when one of these persons gets sick? Do you readily think of their death?
2. How often do you wish that somebody should die? Who? Why? Do you defend yourself?

3. Try to remember when you heard the words death and dying for the first time and what connotations you connected with those words.
4. When did you see something dead for the first time? Was it an animal like a rat, bird, dog or horse, or a human being?
5. Do you ever have the wish to kill? Whom do you want to kill and why?
6. Do you imagine how the killed person would feel or how he would look? Do you think that the person should know that you killed him?
7. Did you ever kill an animal, insect, bird, worm, fly? How did you feel about killing them?
8. What do you think about (*a*) fishing, (*b*) hunting; (*c*) war? Do you connect immediate thoughts of death with these activities?
9. Do you think you are cruel towards animals and human beings? If so, give instances.
10. How do you react to jokes, slang, witty sayings concerning death, heaven, hell, etc.
11. Did you ever see a corpse? If so, how did you feel when you saw the first one?
12. What do you think when a contemporary or rival dies?
13. How did you regard the death of a young person? an old person? an infant?

One sees at once that what the questions ask of each subject is not that he state his actual beliefs or opinion about any particular fact but instead that he report what his introspections about these are. Such questions can't be used at all with younger children and only to a very limited degree with older ones. In order to get answers from the young child it is necessary to give one's questions an objective and logical turn. One cannot, for example, ask, "What ideas or mental pictures do you have when you think of death?" One must ask instead, "What happens when a person dies?" "What does the corpse look like?" Or, "Would you like to die?" "Does it hurt to die?" etc. In other words, our questions must be so formulated as to enable us to find out what the child's actual experiences concerning death have been. It is only in this way that we can find out what conception of death the child actually has, and what rôle it plays in his mental life.

When we started these investigations the discussion method was the principle means of obtaining our material, although much attention was also given to our subject's spontaneous utterances concerning death as well as their spontaneous attitudes towards and manifestations of aggressive behavior. Later on, this method of obtaining data was supplemented by still another technique. A series of 8 pictures were shown to every child and, as these were successively pre-

FIGURE 1

sented, the child was asked to tell or describe what it saw After it had finished its spontaneous remarks the child was then questioned about one or another detail of the picture and its answers in turn made the basis for further discussion The pictures, shown in Figures 1-8, were the following.

1 A girl fainting One man standing, another trying to revive her, bending over her

2 A woman dying A man in the foreground weeping Three girls, half clad, who have just entered, very frightened

3 Vaudeville scene The magician thrusts a sword-like needle into the body of his assistant who holds up his hands without showing any signs of distress

4 A ghost (The ghost of Edgar Wallace), directing the fingers

FIGURE 2

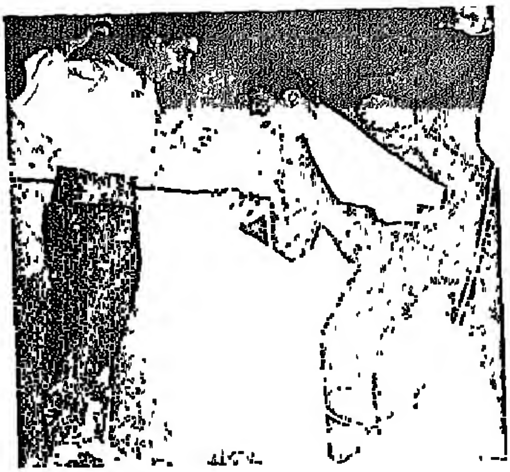

FIGURE 3

FIGURE 4

of a female typist who has her eyes closed. Supposedly he is dictating detective stories.

5. A man reaching out of his tent in the desert sees with horror a skeleton half covered with sand. A bit of cactus is nearby.

6. A ghost (supposedly that of Sir Conan Doyle) visits his sleeping wife who has a tender expression on her face.

7. The picture of an old woman who has just fired a shot from a pistol at a younger woman who is collapsing on her knee.

8. Eight Russian spies hanging from gallows. Some people nearby watching.

Still another technique was employed with the younger subjects. A porcelain doll was placed in front of the child and, while it was

FIGURE 5

asked to look on, the experimenter poked the doll forcibly with his finger so that it fell down on the table with more or less of a bang. This procedure was repeated twice without a word being spoken, and then the doll was once more placed upright on the table. Upon observing this play most of the children would make some remark such as, "you have knocked her over," "you have killed her," "she is dead." If a child made no remark he would be asked, "what has happened?" and his replies noted. Generally, it, too, would then give some similar answer. Most of the children would remain content with observing the experimenter. But some, usually the hyperkinetic ones, would spontaneously resume the play where the experimenter left off, and continue setting up and knocking down

FIGURE 6

the doll for a greater or shorter length of time. This test helped to bring out the aggressive tendencies in children in whom these tendencies were otherwise not apparent.

SUBJECTS

The subjects in our investigations were 76 children[2] between the ages of 5 and 15. Sixteen were under 8 years, 14 were between 8 and 9 years of age, 8 between 9 and 10, 15 between 10 and 11, 8 between 11 and 12, 6 between 12 and 13, 5 between 14 and 15, and 2 over 15 years of age.

Two of the younger children and 4 of the older group were hyperkinetic with an organic background. Three were children who suffered from epileptic fits and 9 were mental defectives. The remaining were, for the most part, children who had been classed as

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[2] There was only one child of 5. Undoubtedly it would be worth while to extend the investigation to a study of children of even still younger ages, but probably this would require some change of technique, particularly in the matter of eliminating verbal responses and introducing more extensive play techniques.

FIGURE 7

behavior problems. Three of these showed schizoid features so that a diagnosis of early schizophrenia might possibly have been made

Results

In going over our data, the most effective way of presenting our basic findings seemed to be through a summarization of the protocols obtained from our 16 youngest and approximately normal children These will be given in the form of general "principles" illustrated by examples from individual protocols These will later be supplemented by more extensive summarizations of additional cases

1 The first strong impression one gets in discussing the problem of death with young children is that these *children deal with*

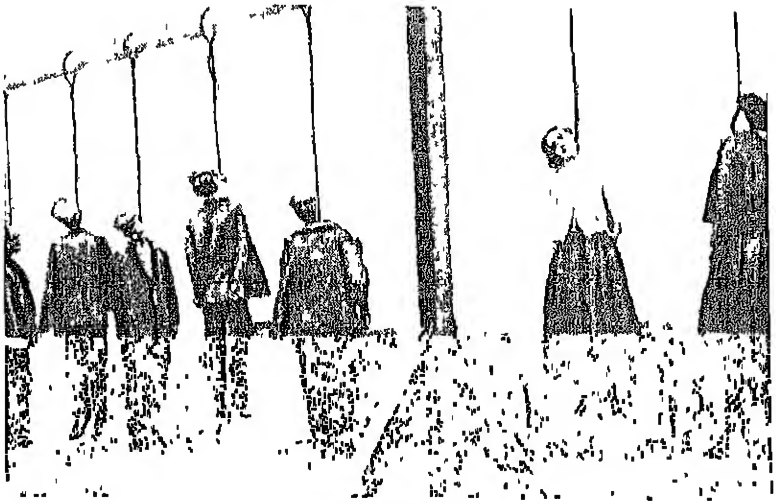

FIGURE 8

death and its paraphernalia *in an utter matter-of-fact and realistic way* Thus, Edward C, 6 years old, IQ 120, answers the question *"How does one know that someone has died?"* with, "One listens to the heart" "I saw my father and mother dead" "They were good people" "I think they are still under the dirt" "Do you know that the man who put my father and mother under the ground got a lot of money?" (*What else?*) "Anytime somebody dies they put flowers under the door" (*What did your father die from?*) "Pneumonia" "When my mother died everybody said, 'don't cry' but I know better" (The child's mother had died suddenly in a doctor's office while receiving treatment) Again, Edmond D, 6 years old, IQ 115, answers the question *"What does a dead person look like?"* with "At first they look like they looked before, afterward they are a skeleton" (*How do you know that a person is dead?*) "They do not move I touched them when they were asleep" "When they are alive they move, when they are dead, they don't move" Louis C, 7 years old, answers the question, *"What happens when a person dies?"* thus "It goes in a big box into the ground, right in the ground, nothing else" "They put flowers on top" (*Can they feel?*) "No, they don't feel

nothing When they feel they are not dead" Miriam K, 8 years old, gives a matter-of-fact description of how a dead person looks, of a funeral etc Thinks that the dead are exhumed (*What does a dead person look like when dug out?*) "Dirty like a pig" Richard M., 7 years old, IQ 103, says, "I saw my mother in a box They had her in a room, my father took me there" Angelo R, 7 years old, IQ 98 (*What happens when a person dies?*) "They bury him and put him in a coffin and they put him in a deep hole They put flowers there" (*Does he stay in the coffin?*) "He goes to a cemetery, they make a funeral" (*Does he stay there?*) "Sometimes they go to see him and put flowers on him He stays there"

2 The children may clearly distinguish between their own observation and what they have been told Edward C says, "A kid told me about devils I don't know whether it is true" "How should I know that they are in heaven? I am not a fortune teller I heard somebody say the angels take the soul. But I am not sure about it. They read it out of the Bible I did not see it myself but I am sure that they are lying under the ground. I saw it." Edward G, 7 years old, IQ 85, says, (*What happens with a dead person?*) "He stays in a box." (*Hell?*) "I have not seen it in school." (*What do you think about God?*) "I have never seen God in school" We may speak about the *skepticism concerning the unobservables*

3 Children do not always show such a critical attitude—*often they accept the convention* Patrick C, 6 years old, IQ 99, says, "A little boy died—I saw the casket" (*Where is he now?*) "He has fun with God—when you are bad the devils put you on the fire"

4 When there is *contradiction between convention and observation,* the child often shows no tendency to solve this contradiction and remains insensitive to it George M, 6 years old, IQ 103, says, "Dead people go down a big hole and then they put a lot of sand on" "Then they don't feel anything" "When we are good we go to heaven We don't feel nothing up there The hole that they put people in is near to heaven, right next to it If you are bad you go to hell and burn up. Nobody can help It hurts but you don't know if you are burnt or not. It's better to go to heaven and to be good"

5. Closely related to this insensitivity to contradiction is *naiveté in solving problems* Angelo R (*What does a dead person do in heaven?*) "He flies around with the wings" (*What else do they do?*) "They eat whatever God gives them" (*Can a dead person*

feel?) "No" (*But when he goes to heaven?*) "Yes, he can feel." An adult post-encephalitic of normal intelligence answered similar questions thus "After death one goes to heaven and becomes an angel" (*What do angels do the whole day?*) "They fly around."

6. All children emphasize the immobility of the dead He can't walk, he can't see, and he can't feel. George M, 6 years old, says, "He can't eat" Another child says, "A dead man never feels." The child therefore looks upon *death as a deprivation.*

7 Richard M.. "The devil does not give food" Edmond D., 6 years old, IQ 115, "The devil eats them all up" (*Do they feel it?*) "Not when they are dead" *The devil punishes orally by withdrawing food or by devouring*

8 *Children do not believe in their own death* Louis C., 9 years old, IQ 118, (*Do you think you will die?*) "No, I don't know" George M.· (*Can a child die?*) "No, boys don't die unless they get run over." "If they go to a hospital I think they come out living." Patrick C: "I never die when I am sick—I stay." Edward G.. "I shall not die—when you are old you die I shall never die When they get old they die" But afterwards he says that he will also get old and die One's own death is therefore either frankly negated or it appears as such a distant event that one has not to worry about it Old age, in the minds of most children, is like a far-off land, so remote that even speculation of ever reaching it appears as an idle, useless thought.

9. *To the very young child, death seems to be a reversible fact* Seymour R., 6 years old, IQ 90, "When a man comes and says magic he can get up again after he gets dead They put him in a grave; he stays in the grave until Saturday, then he may come out." Patrick C., IQ 99, "A boy came back when he died. He did not die, he was in the funeral with his mother His mother was in the casket." These two children were the ones we found giving actual expression to this belief A third, Catherine K, 6 years old, made remarks which might be interpreted in a similar way, but even Patrick C., who seems most positive in his belief, says occasional things which cause one to suspect that after all he does not actually believe that the dead become alive again. At all events, however, most children when asked whether dead can come back, answer "No."

10 *Death may be the result of disease* Patrick C· "When you go out in the rain you can die The baby got it He died almost—poor little thing We saved him, we brought him to the hospital" Seymour R.· "My uncle never gets sick They get sick by pneumonia (says ammonia)" "When somebody gets sick

they take him to a rat cellar and kill him" (*Why?*) "Because they say he is a crook" This last instance shows how difficult it is for a child to believe in natural death. But Edward G says, "They die by throat disease" Miriam K., "By pneumonia." Richard M., "When they get old."

11 The knowledge which the child has about these topics seems to depend almost wholly on what it hears by chance It is, therefore, rather scattered and unreliable. But the child does not hesitate to generalize its limited knowledge, a fact which may be referred to as the child's tendency towards *undue generalization*

12 James H., 5 years old, says, "My grandfather died by eating too much dinner." *Death by overeating.*

13 *Death as result of violence,* is a connotation which the children form very easily. Seymour R "Uncle died one year ago—his head has been cut off" (*How do people die?*) "They stick a knife in their heart" George M "Dogs die when they get run over" Angelo R. "A lady died from fire." Edmond D "When they starve—when they get poisoned—when anybody stabs them." Seymour R makes a compromise by saying that sick people are killed Patrick C says, when picture 1 is shown to him, "They killed the lady" (*Why?*) "They did not like the lady."

14 As a compromise Edmond D. says, "God makes them die. He strikes them dead." *Death is the result of the violence of God.*

15. *Fear of death is rare* Only Patrick C is afraid that an old man with a beard may come and kill him

16. Our children said almost unanimously that they do not want to die, even when they have just before declared how nice it is in heaven One hears answers like (*Would you like to be dead?*) "No, because I don't want it" The word death is seemingly a hollow shell which points to something agreeable or disagreeable although its exact content and meaning is not known. But while *the word is only a shell,* still it lends a general direction to the thinking of the child; the child gets this direction from the attitude of the adult.

17. *Distinct suicidal ideas* may be entwined with the idea of death Such ideas were in the foreground in the case of Edward C., who felt very inferior because of the antiluetic treatment he got. Both his parents had died in short succession, the mother during an antiluetic treatment His wish to die is a protection against discomfort which he has to stand and also an escape from the feeling of inferiority "I'll kill myself if I am a court case." (The word "court case" here is also an empty word-shell) A 10-year-old boy said, "When I cry I want to die" Alfred M.,

an intelligent boy, 8 years old, IQ 126, says, "They make me mad —my mother, the nurses I want to die because in heaven they do not make you mad I want to get sick and die"

18. Children are, on the other hand, always *ready to believe in the death of others* The transition from life to death seems to be simple to them, when others are concerned. An analyzed patient remembers (it may be a family tradition) that at the age of two he saw his beloved old nursemaid fall down He said, "Julia dead." When the same patient was 10 or 11 years old, he ate some sharp pickles which were pilfered with his brother from the guest table, he felt a terrible burning in his mouth, and said to his brother, "Do you think we shall die?" Almost all of our subjects responded to the first picture of the series with the remark "She is dead" So, for instance, Edward G.: "A lady died, maybe somebody killed her." The death which children are ready to believe in is generally violent death. (Cf 13)

19. *Children are ready to kill.* Harold W., 6 years old, IQ 96, generally an amiable child, says, "I'll sock you If I had a stick I would stick it in your . . . (points to the genitals of the examiner). I'll cut your head off" John A, 7 years old, an aggressive child, says, "I kill you, I break your neck." (Tries to hit) George M says he does not like the kids who call him by the nickname "Moonshine" and, therefore, would like to kill them. One may say again that the content of the word "killing" may not be fully grasped But the empty shell of the word carries more meaning with it than one is generally ready to concede (Cf 16.) Thus the last-named child, questioned again three days later, protests, "I am not killing nobody," and when relieved of the fear that the examiner entertained such ideas, answered the question (*How would you kill?*) "With a gun, spear, knife."

20. *The tendency to kill may come out only in play* As in Edward G, who denies strenuously any wish of killing and who also does not make any spontaneous remarks which would show such a wish. But if one lets him play with the doll, or with the soldiers, he indulges in repeated killings. This is important from a methodological point of view The answers of children are directed to the examiner who is feared as an authority and substituting father The child is therefore liable to repress aggressive tendencies, to hide them and not to talk about them One must give the child opportunity to express himself, and to show these tendencies without the fear of being punished The additional methods of showing pictures and the play technique afford such an opportunity.

21. How much the child is filled with the idea of violence and death can be seen by the way in which children react to ghost pictures Iona D., 7 years old, IQ 109, says to picture 6, "He kills people—the skeleton kills" Angelo R says to picture 5, "He is a Frankenstein, he is trying to kill this man—he is coming out of the dirt." He says to picture 6, "A girl is asleep—a man comes to kill her" (*Why?*) "She is a crook who steals money—she wants to buy clothes They have her picture in the paper"

22 *The killing ghost is a natural part of the world God appears as a stage magician* Edmond D. "God makes them come up by magic He puts his hand down—he comes up The chair goes and gets the dead person who does not lie. If they lie, the devil comes up—he makes the magic When you say 'presto' something comes up When God says 'presto' they come up to him"

23 *Appearance and reality are not sharply differentiated.* Edward G says to picture 3, "A show This is a bad man—this is a good man I like him. This man sticks something in him—he will die. I can see it is a show—there is a stage. Maybe he will not die." But this is an isolated instance.

24. The child feels the urge to pass a moral judgment on every person and picture. Edward G says to picture 3, "He is bad because he is fighting him." Patrick C. says to picture 1, "A bad man kills a lady." Seymour R. (Cf. 10) says, "They kill him—they say he was a crook" Every protocol contains instances of the *urge for moral orientation*

25. *The professed morality is utilitarian.* The child fears punishment. Edward D answers, (*Would you like to kill?*) "No, I would not like to go to jail Maybe somebody gets the cops after me and puts me in jail."

26. The foregoing is the typical answer *Religious morality enters relatively rarely into the child's attitude toward death* Only one case, Richard M., says, (*Would you like to shoot somebody?*) "God would not like it."

Discussion

Before considering the "principles" just enunciated and the material from which they have been derived it will be of interest to call attention to some of the more formal aspects of the child's thought processes, the examination of which will enable us to better understand a number of the more outstanding principles, namely, numbers 1, 2, 4, 5, 11, 16, 23. These aspects pertain principally to the significance of words as used by children, a subject which

needs particular attention because of the fact that so large a part of the child's education is verbal.

When an adult uses words, whether singly or in a sentence, the words, apart from any general meaning which they may have, point to some specific content These contents are usually not fully conscious, at least not at the moment when they are spoken. The meaning of the words are generally vague, and it is only rarely that a given word has a specific content or bears upon a clearly singly defined object, as for example, the word "tree," when a person pointing to one would say, "this tree here" But even in this instance the exact content of the word is not entirely clear because we do not know for certain just what qualities of the tree he may have had in mind Nearly always they give us connotations rather than definitions in the scientific sense. Nevertheless, when used in sentences or in ordinary speech, words do have some definitely circumscribed meaning or part meaning The speaker wishes to point out some specific fact or particular attribute, and this is particularly true of words as used by children.

In addition to expressing meanings, words also incorporate some emotional content which pertains not to the word itself but to the attitude which the speaker has towards the object referred to. For example, when one says, "This tree is tall" the content of the sentence goes beyond mere statement as regards the size of the object. It also carries with it, unconsciously to be sure, the individual's attitude towards it. "This is a tree" also says, for example, "See, this is an object which does not have a very great influence on your life. There is no reason for getting very much excited about it. Still, it ought to give you some pleasure to look at it. Why don't you?" Most statements directed towards others have some sort of affective implications, and these implications often form the essential part of its content

We have digressed a bit on this somewhat philosophical discussion of the meanings of words, because the meanings which words have for children are very much more complicated, if not more complex, than those which can be found in dictionary definitions Particularly important for the child is the emotional content which it has been made or learned to associate with various words, because it is very often the emotional attitude of the speaker rather than what he says which is impressed upon its mind This is so because

many of the words which the child hears for the first time are used *in orders, warnings, admonitions,* and exhortations which they receive from adults Words so used generally do not so much define things as situations, they do not recall particular objects but experiences associated with them

The child lives continually in a world of verbal uncertainties and mysterious implications full of threats and dangers (16). It tries to escape *from these verbal mysteries* by seeking refuge in concrete experience. This explains the principle of the child's realistic attitude (1) and the principle of undue generalization from a single concrete experience (11). A single concrete experience is sufficient for the child to shut out uncertainty The process of development from the concrete to the abstract mode of thinking consists, in part, of the incorporation of the experience of others into that of our own.

The child at first makes use of words the full meaning of which are not at all clear to it What it does understand forthwith is the emotional implication of words. Hence one may speak of the word as a "husk" The word is a sort of a shell (*Worthulse*) which incases at once both a cognative and a conative core. But these two cores are not equally substantial, the conative one is by far the stronger. The conative aspect of a word is the first to impress itself on a child It is only later on that the child is able to associate more definite meanings to words, when it does so, it may be said to have made its first important step towards a rational use of language. These first rational connotations, it must further be observed, are the meanings which children attach to concrete terms

The child in the first instance tends to believe everything it is told. In so far as the assertions of an adult pertain to an observable fact, the child finds no difficulty in accepting them But since much of what adults tell children does not pertain to things which children directly observe, they are in constant need of exploring for themselves, and explaining in the best way they can the ideas behind the non-observed objects. Children do this in one of three ways: (1) They may doubt or entirely reject the non-observables (2) They may accept the conventional meanings without asking for their real contents (3 and 5). (3) They may be altogether insensitive towards contradictions between *observables and non-observables,* a situation which is achieved by incorporating the unobservables un-

critically into the bulk of their already acquired experience (4). The task of bringing the observables and unobservables into a consistent whole is, of course, never solved completely even by the adult. This is particularly true as regards his ideas of death and life after death. In the case of the child, the integration is even less complete, but a portion of its ideas about death are based on sound observation. Thus the dead are deprived of motion and feeling (6) and, what is especially important for the child, do not eat. The paraphernalia of death are noted in detail, although very often the child makes no connection between the fact of death and its symbolic appurtenances

This shows that the child has no special urge to synthesize or unite impressions received at different levels of experiences His experience is thus never completely organized. On the contrary, he has a tendency to rely almost exclusively upon immediate sense impressions This, for example, is illustrated by the attitude of one of our children who identified acts of God with the actions of a magician, and for whom, accordingly, resurrection became a matter of mere observation. For such children stage trickery and reality are almost identical (23).

The child is primarily not concerned with its own death (8), though, having observed the death of others, it is ready to accept its own as a possibility. Nevertheless, it disbelieves very strongly that it will die. Even when it considers its own death, the child projects it into a future which is so remote that it has very little reality This is in part due to the fact that only the immediate future has any reality for the child The next meal, the next day, and possibly the next month's outing are the only events which have anything knowable about them, anything beyond that cannot be appreciated. Old age exists for the child only as an intellectual possibility

The child knows through its own experience or through information received from others that human beings die. This knowledge it generally accepts. In fact, it is very ready to believe in the death of others (18), possibly because death for the child primarily means merely a kind of deprivation The person who dies is deprived of his possessions and the affection of those near to him, etc. And since it has no objection to depriving others of these things, it shows no revulsion against the idea of killing Pos-

sibly because the child has no reason to fear complete deprivations (15), *the idea of its own death is largely excluded from its beliefs* It thinks that the only way it can die is through some act of violence (10). Lack of observation of the dead and what happens to them, as well as the fact that it is itself alive, leads the child to the belief in the reversibility of death (19). Death through violence is very much easier for the child to understand than death through disease Because of its special interest in food the child also believes that death may come from overeating (12).

The idea of death through violence is closely ingrained in the child because of its own aggressivity. The young child, especially the aggressive young child, is constantly destroying things The ability to destroy gives the child a sense of power, and is accordingly a source of pleasure. Children fear to express their destructive desires verbally, but these wishes come out readily in their play actions (20)

To the child, anything that is unexpected and unusual may kill—ghosts kill and so do the dead This may explain its belief in the ability of a murdered person to come back and take his revenge on the murderer (21)

The child's idea of hell reflects in part the attitudes of the adults about him, whose ideas on the subject are usually very childish (7). Its morality concerning death is derived from its fear of punishment, and, in this connection, it is interesting to note that some children report that the punishment for killing a person is incarceration (25). The morality may also have a religious character (26). But even here it is connected with ideas of punishment. This is, no doubt, due to the fact that the child's morality, whatever its nature, is derived from a system of education based on reward for being good and punishment for being bad

The child thinks about death only when other kinds of deprivations seem unbearable Death, however, seldom has the character of something definite and final Death does not seem to be something that lasts, because the child's own deprivations are usually not of a permanent or lasting kind This fact, too, makes it seemingly easier for the child to wish the death of others, and to speak of killing people without any conscious-stricken feeling

Case Histories of Younger Children

Edward G, age 7, Binet IQ 85. The child was brought in as a behavior problem and sex "delinquent" He is an adopted child and came to the family by a kind of fraud The mother hates the boy and accuses him of sex activities with her own child, a little girl of three. She has serious difficulties with her husband who takes the part of the boy. The child is amiable, active, denies any knowledge of sex, although he is supposed to have played with the sex parts of his sister He tells in a matter-of-fact manner that his father went to see a dead man, that he did not see the dead, but that he once attended a funeral

(*Where does the corpse go?*) "In the cemetery, in a hole; the men put dirt on him, then they go away." (*Does he feel?*) "No, he can't feel, a dead man never can feel or come back" (*Does the body smell?*) "No, the cover is on him" (*Did you ever see a dead cat?*) "Yes" (*Does it look nice?*) "No, a cat got run over and the eye fell out I saw it long ago." "I would not like to kill a cat. I would get put in jail" (*What about chickens?*) "I kill chickens, my mother kills them" (*How?*) "With a hatchet." (*Does it hurt the chicken?*) "I have never seen nothing, the blood comes out" (*What happens with a dead person? Can he come back?*) "No, he stays in a box" (*What about heaven?*) "They did not tell me about heaven They go in a box and stay there" (*Hell?*) "I have never seen God in school."

He says it is not right to kill You go to jail and stay there. (*How do people die?*) "They have something the matter with their throat" Says he does not want to die. "When you are old you die." (?) "I shall never die When they are old, all get old, they die" But then says he will get old too and die "My father is old but he is not dead yet." When the pictures are shown to him he gives the following answers.

(1) A lady dead (*How did she die?*) "Maybe someone killed her"

(2) Someone in bed All scared Maybe there was a bad lady in the bed She is sleeping

(3) A show This is a bad man and this is a good man I like him This man sticks something in him He will die I can see it is a show There is a stage Maybe he will not die

(4) A lady (pointing to the man) Looks like a man A white man

> (5) Looks like a devil and he looks at him and is afraid He is bad because he frightens him.
>
> (6) Looks like a man flying and a lady sleeping
>
> (7) A bad lady shooting a good lady (*Where did she buy the gun?*) She is dead.

This child in his talk appears to be very mild and pacific, but manifests much aggressivity in his play

Patrick C., chronological age 6½ years, mental age, Stanford-Binet 6-6, IQ 99 Amiable child with slight speech difficulties Orphan, has been with many foster mothers and generally amiable, But from time to time moody with uncontrollable outbursts of temper

"I have three mothers They were my mothers Yes, I like them. I don't bite mothers I don't kick mothers If I kick anybody I say 'I didn't mean it'." (*Do people die when they are sick?*) "I never die when I am sick. I stay I have felt like 'pendicitis' (appendicitis). My sister had it. My sister almost died in the hospital" (*What happens when a person dies?*) "The funeral comes" (*Can you come back after death?*) "A boy came back after he died. He did not die. He was in the funeral with his mother. The mother was in the casket. A little boy died. I saw the casket" (*Where is he now?*) "He has much fun with God When you are bad the devils put you on the fire that harms you. I don't like to go into the fire Do you? I am not going to die. I get old. They take the soul out of the body. (?) The soul is in the heart. The soul is with God God made me. God makes everything." (*What do devils do?*) "They don't do anything, they kill. They kill God on the cross The devils have big green ears." (*How can one kill?*) "They stick a sword right into you." (*Why do funerals go slow?*) (*Would you like to be killed?*) "I would not like to kill anybody. I help the ladies. I had a real mother. She died. My father didn't. When you go out in the rain you can die The baby got it. She died almost. Poor little thing We saved him We brought him to the hospital." He talks rapidly, spontaneously When the pictures are shown to him he gives the following answers:

> (1) A lady and a man. (*What happens to her?*) They killed the lady (*Why?*) Because they did not like the lady Some man can kill a lady A bad man kills a lady

(2) Three ladies One sleeping Another lady is up (*Why is she in bed?*) Tired

(3) Two men. A man sticking something in. Anybody can do that They are killed They kill you He can be put in the electric chair (*Where do they put him afterwards?*) They put him into a big hole and cover him up If anybody stepped on it, he would fall down

(4) A lady A man (*What kind of a man?*) A white man (*What does he do?*) He takes the lady away Kidnaps her, puts her into a cellar and kills her I would not kill I would be put into jail for it

(5) He is going to kill him (?) Because he is mad at him He kills him and he will kill him (*Can he move?*) Yes He don't like him Nobody likes a bad man who kills. (*What's the matter with the skeleton?*) He does not know what he is doing He has no eyes, he can't see (*Is he alive?*) Yes Maybe he killed him in the night Sometimes I am afraid that a bearded man will come and kill me

In the doll test he does not knock the doll down. Says also it is not right to do that. Says that he would like to kiss the doll, and when allowed to, takes it childishly and kisses it

George M., 6 years old, mental age 6, hyperkinetic child, restless, agitated, with a great need for bodily contact. Tries to touch other persons and to caress them. His brother has an hyperkinesis of a more violent and active type.

Says he does not like the kids who call him "Moonshine." He would like to kill them. He says that dead people go down in a big hole, then they put a lot of sand on them "They don't feel anything When we are good we go to heaven Don't feel nothing up there. The hole where they put people in is near to heaven —right next to it If you are bad you go to hell and burn up. Nobody can help It hurts, but you don't know if you are burnt or not It is better to go to heaven and to be good I would not like to die." "To die you got to go without your eats." "I don't know why people die. Dogs die when they get run over, and boys don't die unless they get run over If they go to a hospital I think they come out living" Three days later the same questions are put to him. (*What happens when a person dies?*) "They go into a big hole and they put a lot of sand on it. They are buried" (*Do they feel?*) "No, they don't even know that sand is put on

them." (*Why do people die?*) "I don't know." (*Can I die?*) "Yes you can. When girls and boys are men and ladies then they die and their mothers and their fathers die." (*Why do they die?*) "I don't know." (*Can a child die?*) "No." (*Can a dog die?*) "When it gets run over. A cat can die. I have three cats at home. They are run over." (*What is killing?*) "I'm not killing nobody." (*How can one kill?*) "I don't." (*What is being sick?*) "They go to a hospital." (*What happens there?*) "I don't know." (*What about shooting?*) "Soldiers shoot." (*What happens then?*) "They get dead and fall down." (*Why?*) "Because the gun shot them." (*Would you like to kill me?*) "No, because you are nice. I don't kill nobody."

The 8-year-old brother of this patient, William, shows also an hyperkinetic picture. He is aggressive, hates other children, and had almost choked a girl to death before he came in.

"I went to choke the girl because she gave me names." (*What happens when you choke a person?*) "She dies." (*?*) "They go to heaven, bad children go to hell. The devil comes every night—he takes them on his back and puts them over fire and burns them up. Then he comes back and takes other children who are awake." (*Who told you that?*) "I know." (*How do you know?*) "One night he came to my home, he knocked on the window, my grandmother heard him and went to the window, opened the window, then my brother was praying not to take us away, he said 'all right, I do not take you away'." (*Why do you hit other children?*) (*Are you strong?*) "Yes, I am strong. I don't know any other way to show that I am strong." On another day he says, "I was in heaven, my brother too. It does not look like anything else." (*Will you die?*) "I shall die at the end of the world." (*Would you like to die?*) "I would not, I want to live instead of going to hell or heaven." (*Why is it hard to die?*) "You might not go to heaven." (*Did you ever see a dead person?*) "I don't know. I saw an American soldier shot in my block." Says he also saw a dead dog. "They bury them as soon as dogs and cats die. One of my cats was killed by a car who fell down on him. I cried. I never wished somebody should die. It is bad. I never wished anybody's death. (*Is it all right to kill?*) "No." (*Why not?*) "I don't know. It is nasty to kill. It is not nice to kill."

Case Histories of Older Children

The following are protocols of children from 8 to 12 years of age:

Alfred M., chronological age 8½ years, Binet IQ 128. Behavior problem, restless at night, generally amiable and attractive

"I once saw a dead girl in an undertaker's parlor." (*What does it mean when one dies?*) "You never open your eyes again You go up to heaven. Wait till I get there and find it out. It is bad. I do not want to mention the word (hell). God wants them to die He just wishes them to die and they die The soul goes up and not the body" (*Can one see the soul?*) "No." (*Does the soul feel?*) "No." When you are in the ground you dream that you are in heaven A sick spell comes over them Somebody kills them." (*Is it right to kill?*) "No" (*Would you like to kill somebody?*) "You think so, therefore I said it" Says he was never afraid that he may die "They make me mad, mothers and nurses, so that I want to die because in heaven they do not make you mad." (*How would you like to die?*) "By sick spells. I want to get sick and die" (*How long will you live?*) "61 or 62 years. That's when most people die. The man across the street just died" (*Would you not miss something if you would die?*) "I would miss meanness, I don't care." But he adds, "I would look around the world and see everything before I die I do not want to miss it."

We deal here with the reactions of an intelligent and aggressive child who considers the answers of others as a particular meanness. One can easily see the connection between his answers and the answers of less intelligent and younger children He thinks, on the one hand, that death is an immediate act of God, but at the same time is aware of the fact that one may die by disease He generalizes similar experiences by saying that most people die at 61 or 62 His solution of the problem of life after death is unusual and shows his high intelligence.

Joseph C., 8 years of age, average intelligence, comes from a very unstable family, has been in many institutions, likes, according to his mother, to dress like a girl, a child who seeks much love and is aggressive in a rather insidious way. He is afraid of open fights He always complains that the other children are aggressive towards him.

"The doctor says if they hit me on the heart I drop dead." (*What happens when a person is dead?*) "It does hurt sometimes.

They fall on the ground and hurt your head." He is not quite sure whether it makes a difference whether one is hurt after death or not. "The person who dies gets hurt. They hurt their head or their back. They get hurt before they die." (*Is it painful?*) "Yes, afterwards they get buried." (*?*) "No, they don't feel it. If he is good, they go to heaven." (*How?*) "God takes them out of the box and brings him to heaven. God makes him alive. If he has been bad he goes to hell, and the devil burns him up." (*Does he feel it?*) "No, in heaven they are happy. If I was sure that I go to heaven I would like to die." (*What is the difference between being alive here and in heaven?*) "They are both the same." (*Are you alive in hell too?*) "You get burned. He takes you with a fork." (*Does the body remain in the grave?*) "God opens the coffin and takes it." (*Did you ever see a dead person?*) "I saw a little baby, it was a little girl, she had a nice face and nice clothes. I once saw a dead dog, it was frozen. I also saw a dead cat." (*Was it nice?*) "It was a fresh cat which used to scratch." (*Did you ever wish to be dead?*) Shakes his head. (*Did you ever wish to kill somebody?*) "I am sure no. (*How can one kill?*) "With a knife or with a gun." (*Why do people die?*) "They get killed by a man with a knife." (*How do others die?*) "They get sick. I know a man who killed a storeman. The next day he got sick." (*Why did he get sick?*) "Because he killed. God punishes him." (*How did the little girl die?*) "The little girl was sick. She got perhaps a disease."

A few days after this discussion he choked a rather passive boy. Reprimanded he says, "He was hitting me before. I did not hurt him." (*Whom do you like best in this world?*) "God, he made us, he died for us."

This protocol shows a hypochrondriac fear of being hurt by others. Death for this subject means chiefly death by violence. Death by disease is a punishment by God. His ideas about heaven and hell are conventional, as is also his morality. This professed morality is purely verbal, and serves as a "blind" for the subject's aggressive and sadistic tendencies which he suppresses only when he has reason to expect punishment and retaliation.

Marion F., 8 years old, mental age 8-8, IQ 104. Child brought in because of sex delinquency about which she speaks calmly and openly. Has had two epileptic fits of long intervals.

(*What happens to dead persons?* "They burn them." (*Is it bad to die?*) "No." (*How do they die?*) "By eating poison things." (*What do they feel before they die?*) "I don't know" (*Do they feel something after they are dead?*) "No." (*?*) "They put them in a graveyard" (*Do they come back?*) "No" (*Did you ever hear about the soul?*) "No." (*About life after death?*) "No." (*Did you ever hear about heaven or hell?*) "No" (*What is hell?*) "A place where all dead people go"

Picture 1. She is dead A man is looking with his hand on the hips

3 He is getting killed (*Is he hurt?*) "Yes" (*Is it right to kill?*) "No. You won't see them no more" (*Did you ever see a dead person?*) "No" (*Would you like to?*) "Yes"

4 A shadow It's her and her shadow

5 A skeleton, face and hands. A man is scared (*Why?*) "The skeleton will kill you" (*Can I become a skeleton?*) "No"

6 She is in bed He is coming down to her

7 This lady is shooting her.

8 These ladies are getting hanged up

(*Do you think you will ever die?*) "No" (*Will I die?*) "No." (*Live forever?*) "No." In playing with tin soldiers and tin cars, she knocks down a soldier after a period of hesitation and says the car killed him

While on the ward, she told the nurse and some of the other children that bad people are taken from the grave and sold at the market

This is an unimaginative child with little inner and outward activity But in the world which she knows the idea of violence plays an important part Death occurs by poisoning and dead bodies are sold on the market

Ramirus C, 9 years old, mental age 10-1, IQ 109. Porto Rican child, amiable, chivalrous; stole money from his parents in order to buy something for his friends and to distribute candy among other children. Very generous on the ward

(*Is it nice to die?*) "No, I want my life" (*What happens after death?*) "They take the things out of the body and stuff it with cotton They bury him." (*Does he feel?*) "No" (*What happens

after he is buried?) "They burn him. The man who takes things out of him keeps the stuff." (*What happens with the corpse in the grave?*) "They leave him there where he is buried" (*Can one come back after death?*) "No, because he is all stuffed with cotton and is dried up." (*Does he feel any more?*) "No" (*Can he go to heaven?*) "Yes, because God sends him up. He sends angels down when the person is buried They take the whole dead person. After they take him the grave is empty" (*What does a person do in heaven?*) "He remains with God God takes care of him." (*Is he dead?*) "Yes" (*Does he feel?*) "No" (*How does the Lord take care of him?*) "He stays in a box." (*What happens with a dead person?*) "He never gets back to life." (*Does a good person come back to life again?*) "Yes" (*Is there a hell?*) "No." (*Where is heaven?*) "In the sky."

> *Picture* 1. A girl dead. They killed her. (*Why?*) Because she was bad. (*Is it all right to kill?*) No (*How do persons die?*) Because they kill them Sometimes they get sick They die (*Will you die?*) If I get sick (*Do you think of death?*) Yes, because I am bad Then I go back to hell
>
> 2. A lady is dead. Her sister.
>
> 3 A man who killed a boy
>
> 4. The girl is dying in the fire Flames It's a head or person
>
> 5. A skeleton (*What is a skeleton?*) When you die he turns to be a skeleton
>
> 6 God He makes the girls sleep.
>
> 7 The mother killed her with a gun She got no right to kill her
>
> 8 People choking. People hanging They got no right to hang them.

This intelligent boy has difficulties in uniting the unobservables with his correct observations of the facts He is ready to believe in the death of others and he is readily inclined to believe in violent death He is caught in a network of superficial moral connotations, due to punishments received from a severe father.

Charles C, 10 years old, mental age, 8-1, IQ 81. When he was 9 years old he was run over by a car. When reporting it he says he was afraid that he would die.

"One feels sorry before one dies" (?) "I had pain Some go to heaven, some don't. They see God and have everything they want." (*Maybe it would be better to die?*) "Only for those who go to heaven" (*Do you think you will go to heaven?*) "I don't know" (*What happens with the body when one goes to heaven?*) "It is still dead" (*Did you ever see somebody die?*) "No. When my brother died I was one year old I was three years when my second brother died (?) I can't remember it" (?) "I saw four or five years ago a dead cat I felt pretty bad" (*Did you care to touch it?*) "No" (*Should one kill animals?*) "No, it is breaking the law" (*Would you like to hunt?*) "Yes" "I would not like war. Too many people get killed" Says he does not want the death of anybody. "It frightens me that my mother has a silver tube in her neck." (Mother wears a canule after trachiotomy) He is afraid that she will die of it The child has been brought to the hospital because he ran away several times from home, and is very much afraid of a severe father "When I go in the cellar I am afraid a man may come down and kill me. I always go up to the top floor (to hide), nobody comes up there."

This child accepts conventions about death and has incorporated them into his experience Experience has taught him to be afraid of death by accident, by murder, and by disease.

Vincent O'D, 10 years old, average intelligence, IQ 92, brought into the hospital because he can't get along with his mother Fainted when he was told that he had to stay in the hospital.

(*Did you ever see a dead person?*) "My uncle, I was about eight, he was in the coffin, it was not so nice" (*What happens afterwards?*) "They go six feet under, then they stay in the ground Then after 5 or 6 years they are only bones." (*Do they feel?*) "How can they, they are dead" "I would not touch one" (?) "It is not nice to kiss a person who is dead You might connect with the germs." "There is a certain kind of powder on them, and something is liable to happen to you." "They can fine you." (*Why?*) "They may think that you want to attack a dead person, to go in and take the rope and try to hide him" (*Why should one attack a dead person?*) "For instance, he knows the dead person's grandmother or somebody, and he does not like them, so he says he will attack them and steal the dead person and hide it." (*What will happen?*) "If a cop catches him with the smell of the dead

person, he will ask him questions, and will send him over the water for ten years" (*Who told you this story?*) "I just made it up." (*Are you afraid of dying?*) "No, I shall die a natural death. I am afraid of shooting and being shot. I shall be about 30, 35 or 50, when I die I might die at that age." (*Can you die earlier?*) "When you are 11 or 12; you can die at any date." (*When do you think you will die?*) "I can't tell You go on a certain time. You live after, if you are created afterwards and if you are in the next world." (*Is there a next world?*) "Maybe there is one. There is another world made already" (*Is it right to kill?*) "No it is not fair" (*Is it ever right to kill?*) "If he does something which he is not supposed to do." (*Did you ever wish that somebody should die?*) "No. But if you hate somebody, what is the use to wish." (*What is an angel?*) "It is a pure spirit. The Catholic Bible says so."

Picture 1. Somebody shot this lady

2 The family or something She died

3. He is putting the sword into another man but he is still alive In a show they do that

4 A woman is typing She is dreaming of a man who is over her.

5 This man owns the tent. He has been dying He seems to be a skeleton up from the ground.

6. She is sleeping The man looks old, you can see his bones.

7 A woman shooting a woman It is against the law to shoot

This child, who is generally very rational in his attitudes, still has an exaggerated fear of the dead (connected with infection), and his idea of death is fantastically related to crime One sees such inroads of the irrational not infrequently in children who on many other points have a realistic, conventional, and rational attitude towards death.

Cases with Mental Deficiency

Among our material the protocols of several of the special groups of children included deserve particular attention. One of these is the group of mental defectives which reveals, in especially striking fashion, the uncritical acceptance by children of conventions and lack of distinction between observables and non-observables.

Frederick D., 10 years old, IQ 68, was brought up in a convent, behavior problem

"When a boy dies he goes to heaven The soul goes up." (*What do people feel when they die?*) "They feel lonesome, they want to see their people again" (*Why do people die?*) "They eat things they are not supposed to eat They pull things up from the ground and eat them" (*Do you know other causes of death?*) "Killing persons, murdering people. You shoot him—he dies. Murderers do that, they want the money." (*Did you ever kill?*) "No" (*Did you ever see a corpse?*) "No All the bones are separated" (*Would you like to see it?*) "No." (*?*) "I saw a dead cat, I felt sad" (*?*) "The poor cat wants to live like us." (*Would you like to die?*) "No." (*Does it hurt?*) "Yes When you stab a person it hurts the person" (*Must all people die?*) "No Some people don't die" (*Do they live forever?*) "They might die, some of them live" (*Do you think that you will die?*) "Yes, I shall die, I don't know why"

> *Picture* 1 A girl. She is dead, I think (*How did she die?*) She killed herself
>
> 2 (*?*) She wants to go to heaven
>
> 3 He got shot by the other man Maybe he did something wrong He feels sad He stabbed him through the heart. (*What will happen to him?*) He will die
>
> 4 A shadow of a man A wall shadow. She is playing (*?*) Something He kills her He is a bad man
>
> 5. A skeleton from the dead people (*Does it feel?*) No. (*Does he go to heaven or hell?*) To hell; he kills people. He is magic (*Can he move?*) He is coming up from the grave, he wants to kill that man
>
> 6 A mystery man He kills people
>
> 7 She is shooting She is a bad lady (*The other one?*) She is a good lady She did not do nothing to that lady (*What will happen to her?*) She will die She is a good lady She goes to heaven, the other don't (*What will she do in heaven?*) She will be happy (*Would you like to die?*) No
>
> 8 People who get hanged They did something wrong

In this case the strength of an uncritically accepted convention is particularly strong Also his moral connotations are very outspoken. But violent death and death by poisoning are considered by this subject as rather natural events He is a child of little

impulses, and considerable slowing down of the mental processes so that the IQ rating obtained with the usual methods does not give a correct impression of his deficiency. Many of the "principles" met with in younger children are particularly outspoken in this case.

Gamalian B., negro, 12 years old, IQ 50, extreme restlessness which turned often into aggressivity

(*What happens with a person who dies?*) "He goes to filth, to undertaker." (*Would you like to die?*) "Not me." (*How does one die?*) "I don't want to die" One can't get any other answers from him.

> Picture 1 Dying She dies with nothing She dies and goes to the undertaker to filth
>
> 2 A lady, she is dying
>
> 3 Sticking in his stomach he dies he goes to the undertaker.
>
> 4. A smoky man She types He points to the lady
>
> 5 A man I know. Kill you A smoky man. He laughing. That man kills the smoky man. The smoky man kills people

A 15-year-old mental defective said that people die when they don't call the doctor "They get double pneumonia." Otherwise she has very conventional ideas.

A 10-year-old borderline defective girl says, "After they die they go to a grave. The worms eating him The heart goes to Jesus, and Jesus is spiritism He can go everywhere." (*What is spiritism?*) "You can't see him." (*Why do people die?*) "Maybe they get bronchitis, all kinds of disease Somebody was shopping for his wife, he fell down dead. Maybe heart disease."

Alfred A., 10 years old, mental age 7, IQ 64.

> *Picture* 1 A lady dead A man is right near her (*What will happen to the lady?*) They'll put her in a coffin (*Then?*) They'll kneel down near the grave
>
> 2. Lady is down in a bed She's dead The other girls are all praying And the husband is like this (imitating the man's posture in the picture)
>
> 3 Man is sticking a knife through other man who's going like this (imitating expression on man's face in picture). (*What will happen to the man?*) Dies.

4 Lady typewriting with eyes closed White man floating in air And the lady died.

5 A skeleton on a ground Man looking at him with eyes wide open. (*What will the skeleton do?*) Kill him (*Get up?*) No, maybe the man died of scare (*Can the skeleton feel?*) No (*How does a skeleton get that way?*) Bone (*Can you hear a skeleton?*) Sure (*How?*) No flesh on you (*When?*) In the coffin a long time

6 Lady sleeping, a ghost there She died (*How?*) By the ghost (*How does a ghost kill her?*) By the hands (*Where does the ghost come from?*) From the dead

7 Lady shooting gun at other lady Other lady died. (*?*) They bury her (*?*) She'll come out a skeleton

8. These people are hanging other people up, and they die They will bury them. Then they turn to a skeleton (*Do people go to heaven?*) Men (*Ladies?*) Yes When you die God takes your soul (*Can a soul feel?*) No (*What is a soul like?*) Like it was nothing (*How does God get the soul?*) The angels get the soul (*What does the soul do in heaven?*) Melts away (*?*) It goes to God (*What does God do with it?*) Keeps it. Bad people go to hell where the devils are (*?*) God makes them go down (*What happens there?*) The devil comes and burns them up (*Do they feel it?*) No

The outstanding feature in this case is the strong tendency to cling to convention and tradition There is no urge to integrate the contradictions between experience and convention The children have a realistic appreciation of death which is generally conceived as occurring through violence, although they know of death through disease and old age. Their mental deficiency shows itself in their answers, but the formal characteristics of their replies are similar to those we found in the answers of normal young children On the other hand, in the case of many of the mental defectives, one gets the impression that their obtuseness towards contradictions generally, and, in particular, the contradiction between the observables and unobservables, is greater than that met with in normal younger children of the same mental age. In this connection it might be pointed out that whereas the mental defective conforms readily to tradition and convention, he nevertheless continues to manifest a primitive cruelty.

Hyperkinetic Children

Mere clinical experience shows a marked difference not only in the behavior but also in the conversation of children of marked motor impulses as compared with that of children of diminished or even normal motility. The hyperactivity of the former expresses itself not only in the form of a general hyperkinesis but also in an increased mental activity, especially as it concerns the child's phantasy life The two are not wholly unrelated, the increase of the child's motor activity leads it into a closer contact with objects, and this in turn becomes a stimulus for further phantasies.

The increased motility of the hyperactive child may be of two kinds: The first connected with the more primitive drives leads to a ruthless handling of objects often accompanied by their destruction. In the second the drives are less powerful and may be directed to a more or less useful activity. For convenience, we use the term hyperkinesis for instances in which the child's activity is dominated by the more primitive drive, and the term hyperactivity for cases in which the increased activity has been turned to more purposeful activity. The best examples of pure hyperkinesis are furnished by post-encephalitic children. The following are some protocols from both types.

Lawrence McV , 8 years old, IQ 101, post-encephalitic child with hyperkinesis. Tells phantastic stories.

"My uncle was run over. He was crossing the street and was hit by a car. There was blood coming out of the mouth. He was half dying About 15 doctors came and saved him." (?) "He would have died." (?) "They put him into a grave and in a coffin." Here follows a complete and detailed description of what happens when somebody is buried. Says dying does not hurt, his father told him so "Don't think I don't know anything about dying. They are dead, they never get out. When they go to heaven their soul becomes alive. No, I would not like to die" Likes to shoot, but says, "I would not like to shoot people" Shoots the doll in the play experiment. Reports the following dream "I dreamed that George Washington killed Doctor W . . with a big sword, bigger than this Doctor W. did something to him. Doctor W. punched him in the jaw." "If I dreamed it, he must have killed him"

But every other type of hyperkinesis shows the same type of psychological reaction Robert R, 9 years old, mental age 8-6, IQ 96. When playing with the doll he says:

"She is dying. I shot her down now myself" (*What happens when a person dies?*) "I don't know The funeral comes and they go up to heaven" (*Is it bad to die?*) "Yes." (*Does a dead person feel?*) "No." (*See and hear?*) "No" (*Do you think you will die?*) "I'll die sooner or later." (*Afraid of it?*) "Yes" (*Why?*) "I don't know that" (*Why do people die? What makes them die?*) "They are bad He does not want them to live any longer" (*What makes them die?*) "Somebody kills them" (*But if nobody kills them?*) "It may happen during the sleep in the night time" (*Is it right to kill somebody?*) "God does not want you to kill anybody. That is His command" (*What happens after death?*) "They bury him with shovels Then they take him out, then put him in, and then cover him up again They put flowers on, and the funeral goes away." (*And then?*) "The people go away They put flowers on, and then the funeral goes away" (*The body?*) "Stays in the grave forever" (*Does it change?*) "No." (*Heaven?*) "Everybody who has been good." (*?*) "The angels come to take the soul" (*What happens to the body?*) "They make another little baby out of it." (*Bad people?*) "They go down into the ground The devil gets the body." (*What does he do with it?*) "He burns it" (*Does the body feel?*) "No." (*And did you ever see a dead cat?*) "Yes." "I don't like it. It smells." (*?*) "In 1932 I saw a coffin with flowers in it A little boy about 8 years old was in it He died on his birthday" (*Why did he die?*) "I don't know" (*Did you ever kill a cat?*) "No it is cruel God made the cats." (*Did you ever wish that somebody would die?*) "No"

Responses to pictures are as follows

1 A man, a woman dead on the floor (*How did she die?*) From a sword He looks that way

2 A man is sick The other man is crying, don't want to look at him The ladies are scared.

3 Stabbing another man in the stomach. He will die The other man will go to jail

4 She is typewriting That is the wind. She is dying

5 He sees a skeleton He has no skin, only bones He is in the desert (*Can a skeleton walk?*) Yes, it kills you

6 That is the bad man who tries to kill that woman. She is good He is bad"

7. This is a man in woman's clothes. He shoots the lady. (*Why?*) She is good, and he is bad.

8. They hang people because they are bad (*What does one feel before dying?*) One feels cold

This case is an hyperkinesis not of encephalitic origin But his cruel interpretation of death and his cruel play are of the same type as in post-encephalitic children. Seymour A., to whom we have already referred, belongs also in this group of genuine hyperkinesis. Also George and William M. belong in this group, as does still another case of a boy of 13 with defective intelligence (IQ 60).

Hyperkinesis is connected with sadistic attitudes which manifest themselves in a specific attitude towards death, irrespective of whether the hyperkinesis is due to encephalitis, other organic brain diseases or constitutional makeup.[3]

There is no definite borderline between hyperkinetic and hyperactive children. Hyperkinesis and hyperactivity lead very often to actions obnoxious to the adults Their negative reaction and the accompanied punishment of the child only serve to increase the child's sadistic leanings. The following case is an instance of this kind

Frances W, chronological age 8-6, mental age 6-8, IQ 78. She is a lively child who was brought to the hospital because her father attacked her sexually. The interview was started by showing her our pictures.

1 A lady I don't know That is what you showed me before.

2. Children and the devil and a man It is a lady She went in bed. She must be sick She is sick

3 Two men and the devil He strikes this man in the stomach He dies (*?*) He gets burned, and then no more man (*Can he come back?*) He goes down to the devil The devil cooks him and eats him." (*Does the dead feel it?*) "No It is good for him because he is dead" (*What happens when he is a good man?*) He goes up to heaven He gets

[3]In one post-encephalitic child in whom moodiness and negativism were predominent, the characteristic attitudes towards death of hyperkinetic children were not present.

buried, and he belongs to God God blesses his body with holy water (*Can he move?*) He can't because he is dead

4. A lady, a man (*What does the man do?*) How do I know? He wants to kill this lady He can't keep his lady He is not her husband Maybe he wants to kill her He wants to keep that lady

5 What is this, a ghost or what? He scratches you with his fingers when you are bleeding. He takes you in his house and puts you in a big pot and puts water in, and cooks you, and then he puts you in a big dish and cuts you with a big knife and fork He has long finger nails He bites you with his teeth He has funny fingers (*Would you like to be a cop?*) I would like to be a cop or an Indian and kill everybody An Indian kills everybody When he kills them, he cooks them and eats them"

6 A lady and a man. The lady is sleeping He comes by her bed He wants to kill her

7 A girl shoots her It is not nice

8 They got strangled by the neck. (*Do you like it?*) No They are all robbers

Plays destructively with tin soldiers and tin cars. "They are run over, the car takes them away" Commands them during her play "I'll drive you away, and put you in the gutter." "All these guys got run over"

Child is active, lively, runs around much. Is shy and mischievous. Manifests aggressivity which comes out in her motor activities, but her motor drives are not in the foreground It is also more than probable that her particular life experiences are responsible in part for her aggressivity She is at odds and fights with an older sister who is slow and unnaturally dull. (The father is also of an aggressive type). The child's ideas about death and her phantasy life are filled with aggressive tendencies, chiefly of an oral type

This case is intermediate to those in which aggressivity and sadism are definitely bound up with hyperkinesis In hyperkinesis we deal primarily with an increase in the amount of impulses in the hyperactive child, the motility is in a close relation to emotion and the increased motor activity is allied with the patient's general attitudes and interest But in addition to these two types there is the aggressive child whose aggressivity is due to some specific mental and emotional problem. The following cases are illustrative of this type

Thomas C, 10 years old, mental age 11-2, IQ 106, comes from a bad home environment where a drunken father threatens the family. Death means for him mostly a violent death

"Everybody dies if they take poison. That makes you die. I saw a man on the street, who was drowned." (*Would you like to die?*) "No, I'll wait until it is time for me to die." (*How does one die?*) "Some die from being in jail and being kicked by the cop; or on the electric chair; some get shot, hang; some get killed when they are fighting. Some get drowned and die. They can't swim. They can die also when they know how to swim They can die in airplanes People take poison, and throw themselves out of the window." (*Why should they kill themselves?*) "They have wives. When they are drunk they do not know what they are doing They get drunk and kill themselves with a knife." (*How else can they die?*) "Struck by lightning." (*Can one live forever?*) "When it is time for them they get burned or they fall off a building" On another occasion he says "They die when they need to die. God wants them to die He takes them, strikes them with lightning, or makes them kill themselves." (*What did your mother die from?*) "She was too fat." (?) "One may get a poisoned needle" On another occasion, after having enumerated seven ways of violent death, he was asked if he knew of any other way and he answered: "Sometimes they get sick; they eat the wrong stuff; when it is your time to die, God does magic stuff, he moves his hand and you die They all have to die." (*Why?*) "God needs them sometimes when he needs angels."

The aggressivity of this patient comes out only in his phantasies and his attitudes towards them. Otherwise he is very wise and moral, on the ward he is friendly and sociable; he is not at all destructive in his play. His attitude towards death and his theoretical ideas about it contain the only open expression of his hatred of his father The attitude towards death is the common pathway towards which all aggressive tendencies converge. It does not make much difference whether sadism is derived from organic layers, from a general hyperactivity, or from a particular libidinous constellation.

A 12-year-old boy of average intelligence who had put poison into the coffee of his foster mother professes openly murderous phantasies Says. "Sometimes I feel like shooting my father when he

hits me, but I would not like him to die from it. Sometimes I dream that I shot somebody and that I am a policeman I like murder stories in the movies" He was afraid that he would die when he had pneumonia He does not like to see others dead Otherwise he has a rather conventional attitude towards death After the atempt to poison his foster mother he said that he had not wanted to kill her, but had only been interested in how she would react to the poison. It seems as if the act of destruction is more important to him than the resulting death

Our motor equipment as well as our experiences determine our attitudes towards death and allied subjects, and our judgments about them. To inflict death upon another person is to dismember him, also to show our power over him But it may also be for the purpose of inflicting pain on him and, eventually, for removing him from our midst To the child, its own death, so far as it can believe in it, is merely a deprivation, an infliction of pain, a destruction of its body by an external force, at the hands of an enemy.

Accidents and Suicidal Ideas in Children

Three of our children, ages 10, 11 and 14 years, were in serious accidents In all three cases the children said that at the time of the accident they thought they would die They were run over by cars and they looked upon the vehicle as a symbol of unlimited power of destruction In the case of an adult with masochistic tendencies, psychoanalysis revealed early memories in which running after a car was motivated by the wish to come into such a masochistic situation. Masochistic tendencies may therefore lead a person into accidents This was not clearly apparent in two of the cases, and in the third case in which the accident seemed to be psychologically unmotivated, the case history of the child definitely revealed that he was terribly afraid of his father and in constant fear of being attacked in a cellar In the first two cases there was a marked hyperactivity with bravado feelings of the type which leads youngsters into dangerous situations. They were evidently under-rating the dangers of the external world. One of the boys was an unusually spoiled child, the only boy in a family of three adult women, the other child was narcissistic aggressive boy though without any self-destructive tendencies. Both had met with a number of accidents

We have also found in our material 4 cases with the outspoken

wish to die. In a 15-year-old and a 10-year-old boy the suicidal ideas were merely an attempt to escape disagreeable situations Death appeared to be the lesser deprivation Such interpretation of death by the child is not difficult for him because the concept of death does not have much meaning for him. In one case, reported elsewhere by Bromberg and Schilder (1), the outspoken suicidal tendency was the expression of a strong destructive tendency, partly of an oral type. In the case of the 6-year-old, Edward C., both parents had died within a short interval, the mother during an antiluetic treatment. The boy himself had undergone antiluetic treatment which depressed him very much His suicidal ideas were a protest against his disagreeable experiences. He was afraid of being injured physically and mentally. At times when his feelings of deprivation became intolerable he would threaten to kill himself. Thus, on one occasion he said, "If I am a court case I will kill myself."

General Conclusions

Children's connotations of death consist primarily of the idea of deprivation The dead can't move. This connotation is comparatively empty since there is a scarcity of experience which could give it a full content. The child's experience of death concerns death of animals and of other persons, and the disagreeable sensations they get by the sight, touch, and smell of a corpse. The attitude of the adults adds to this connotation the vague atmosphere of disaster. It is ready to believe that this deprivation as any other is reversible.[4] Its own death does not lie in the field of probability The child does not think about it It does not expect complete deprivation, and to it the mere fact of existence contradicts such a possibility. The idea of death does not enter into the child's fundamental conception of life, does not form part of its concept of human existence It does not appear that the appreciation of time is in any way linked to the notion of death The child lives in a comparatively foreshortened world of time. The present is what is outstanding for it Its life goes neither far into the past nor far into the future.

Children are ready to believe in the death of others, which they conceive primarily as occurring through some form of violence, particularly the act of dismembering. To the child, dismemberment is the most obvious means of deprivation, and since it knows depriva-

[4] Cf Piaget

tion primarily as a consequence of the ill will and hostility of others it does not hesitate, when it wishes to punish others, to entertain violent ideas of death towards them Furthermore, it is to be noted that the child lives in a world full of fear and threats. It sees violence everywhere and is ready to emulate this violence itself. Accordingly, its ideas and attitudes about death are inevitably connected with its sadistic tendencies

The sadistic attitudes of children are closely related to the primitiveness of their motor impulses and degree of hyperactivity. Organic factors increase the original impulses (*Antrieb*) and correspondingly the sadistic character of its conception of death. Constitutional factors likewise determine the amount of the child's activity and this activity again influences its attitude towards death. Again the experiences of life may in and of themselves stimulate the child's native sadistic attitudes and give them a direction and form similar to those associated with primary hyperkinesis. Accordingly, in clinical practice it is sometimes difficult to differentiate between a sadism derived from environmental (psychological) factors and those which reach deep down into organic layers.

Death does not appear as the natural end of life. It is the result of the hostility of others it is a punishment meted out for wrongdoing; by extension, the punishing agent may be God Death by disease and old age have no reality for the child It therefore does not fear to die, but does have a fear of being murdered

The body image of the "ego" and the "thou" are intertwined. Aggressivity against others is accordingly easily converted by the child into an aggressivity towards its own person. The child checks its aggressivity primarily because it fears punishment for it. It accepts the morality of the stronger. Tendency to self-punishment and self-destruction are in close relation to the creation of the super-ego. The super-ego, the moral consciousness of the child, is built up through imitation of the parents (identification) The tendencies towards self-destruction have little importance in the younger child. Suicidal ideas are, for the child, an escape from deprivation, in which death appears as the less difficult solution

This investigation being a study of children's attitudes towards death, the aggressive side of their behavior has come to the foreground as a matter of course. But, of course, there are also other sides. There are other things which the child manifests besides ag-

gressivity It has, for example, a very genuine interest in the well-being, in the integrity and completeness of the body of its fellow human beings, etc There are friendly parents who are constantly giving it something, especially food, and the child early becomes aware of such things as kindness and mutual aid But because of the very nature of the subject these aspects of the child's behavior had little occasion to come to the fore.

The teachings of adults concerning life after death are mostly accepted by the child though generally made concrete The connotations and judgments derived from the adult are taken by the child as part of its immediate reality It is not bothered by contradictions. It does not feel the need of making a unitary whole out of the different parts of its experience. Generally stated, the child is an outspoken realist God's influence in actions are taken to be similar to those of a stage magician Ghosts are usually accepted as having factual existence, though classed among the things of life that are dangerous, just as all unusual phenomena are thought to be dangerous In general, the child finds it hard to incorporate conventional, metaphysical, and religious conceptions into the bulk of its experience, and it only succeeds in doing so when it decides to accept these conventions without analysis, however contradictory to experience they may be

Reference

1 Bromberg, W., & Schilder, P Death and dying. *Psychoanal Rev.*, 1933, 20, 132-185

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LES ATTITUDES DES ENFANTS À L'ÉGARD DE LA MORT

(Résumé)

C'est une étude de l'attitude des enfants à l'égard de la mort basee sur une analyse des rapports de 76 enfants Les sujets ont ete des malades dans la Salle des Enfants de Bellevue Psychiatric Hospital, âgés de 5 à 15 ans, et ont compris, outre les problèmes normaux et ceux du comportement, nombre d'enfants hyperkinésiques et faibles d'esprit. On s'est servi de la methode des questions et des discussions, plus un test de tableaux et une technique spéciale de jeu On a formulé les résultats en termes de certains "principes" illustrés par des exemples. Les résultats principaux, entre autres, ont inclu les suivants les notions de la mort possédées par les enfants se composent principalement de l'idée de la déprivation La mort ne paraît pas

comme la fin naturelle de la vie, mais est conçue comme résultat de quelque acte de violence, surtout celui de la perte des membres. Leurs idées et leurs attitudes à l'égard de la mort ont une relation intime avec les tendances sadistes qui à leur tour ont une relation étroite avec l'état primitif des impulsions des enfants et leur degré de hyper-activité. L'enfant trouve qu'il est très difficile de classer les conceptions usuelles et religieuses de la mort dans la totalité de son expérience et réussit à le faire seulement en acceptant in toto les opinions des adultes sans les critiquer. L'enfant d'ailleurs est réaliste et il rend concrètes les opinions usuelles qu'on lui enseigne.

SCHILDER ET WECHSLER

DIE ANSICHTEN DER KINDER ÜBER DEN TOD

(Referat)

Eine Untersuchung der Ansicht der Kinder über den Tod wurde bei den Protokollen von 76 Kindern unternommen. Die Vpn waren Patienten in der Kinderabteilung des Bellevue Psychiatric Hospital. Sie waren im Alter von 5 bis zu 15 Jahren, und stellten ausser normalen und Verhaltungsproblemen auch eine Anzahl von hyperkinetischen und geistesminderwertigen Kindern dar. Die Methode der Untersuchung erfolgte durch die Fragen-Diskussion-Methode, welche durch einen Bildertest und eine besondere Spielmethode ergänzt wurde. Die Ergebnisse wurden als gewisse "Prinzipien" formuliert, die durch klinisches Material illustriert wurden. Die Hauptbefunde u.a. sind folgende: Die Begriffe des Todes bei Kindern bestehen hauptsächlich aus der Idee der Entziehung. Der Tod erscheint nicht als das natürliche Ende des Lebens, sondern wird als ein Ereignis betrachtet, das durch eine Gewaltsamkeit entsteht, besonders durch die der Verstümmelung. Die Begriffe und Ansichten über den Tod sind mit sadistischen Neigungen eng verbunden, die sich ihrerseits auf die Ursprünglichkeit der Triebe der Kinder und deren Grad von Uebertätigkeit bezieht. Das Kind findet es schwer, die konventionellen und religiösen Auffassungen des Todes in das Mass seiner Erfahrung zu vereinigen, und es gelingt ihm nur dann, wenn es in toto und unkritisch die Ansichten der Erwachsenen annimmt. Das Kind is aber Realist, und es macht die konventionellen Ansichten konkret, die es lernt.

SCHILDER UND WECHSLER

A STUDY OF REVERSALS IN YOUNG CHILDREN*[1]

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HELEN P. DAVIDSON

During recent years much attention has been given to the study of children with serious reading disabilities. Orton (30-37) has aroused particular interest in the reversal type of error so frequently made by so-called non-readers and has advanced his ingenious neurological theory of lack of cortical dominance to explain it. This has stimulated interest not only in this particular problem but also in mirror reading and writing, handedness, and eyedness. Dearborn (5-8, 26), Selzer (40), and others have also been studying this problem of reading disability They appear to have accepted Orton's theory as an explanation of reversals but have advanced other theories to explain other types of reading errors Both Orton and Dearborn have drawn their conclusions largely from children with serious reading difficulty Although Monroe (28) used a control group it was considerably superior in intelligence to the experimental group. It is very essential to know how unselected young children learn to read before drawing conclusions about non-readers. Gates and his assistants (16-21, 27) have done excellent work in this field of beginning reading but much still remains to be done.

During 1926 and 1927 the writer was engaged in an experiment with preschool children (4) which involved trying to teach them to read. Analysis of the errors in reading made by them revealed that they read words backwards with great frequency This led to the question as to whether or not words, to young children, were not independent of their absolute spatial position just as Stern (41, 42), Koffka (25), and others found that young children recognized forms without reference to their orientation in space.

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[1]A summary of this study was given at the annual meeting of the Association of Consulting Psychologists held at the University of Pennsylvania, Philadelphia, May, 1933

That reading is an artificial situation and the left-to-right eye movements necessary to read English have to be acquired are self-evident. Orton (37) has drawn attention to the fact that the ancients were not consistent in the direction of writing they employed, sometimes going from left to right and sometimes from right to left. Even at the present time not all races read from left to right. Buswell's (2) photographs of the eye-movements of first-grade children throw interesting light on this problem of how children look at reading material.

The following study was undertaken to test the writer's own tentative theory based on the results of the experiment mentioned above.

All kindergarten and first-grade pupils attending the four schools with which the writer was associated were tested. In this way a desirable unselected group was obtained. Practically all of these pupils had been given Stanford-Binet tests during the year by the writer as part of the regular routine of the schools. Stanford-Binet IQ's were available for 50 kindergarten and 120 first-grade pupils. Table 1 gives the average intelligence ratings for these pupils. It

TABLE 1

AVERAGE CA, MA, AND IQ OF KINDERGARTEN AND FIRST-GRADE PUPILS

Grade	N	CA	MA	IQ
Kgn	50	5 years 8.8 mos	5 years 9.2 mos	101.2
First	120	6 years 8.4 mos	6 years 7.7 mos.	100.26
Total	170	6 years 5.0 mos	6 years 4.5 mos.	100.53
Range				57-142

is at once seen that the distribution of intelligence for these pupils is a very normal one. Although in the results to be presented the number of subjects varies slightly from group to group owing to spoiled papers, the average intelligence of any group never changes by as much as one point in IQ.

Two tests were used. In the first, or Form Perception Test, geometric forms similar to the Massed Forms devised by the writer (4) in her earlier study were employed. A geometric form was drawn at the left side of a sheet of paper. This will be called the "key" form. After it five other forms were drawn. One was identical to the key and one was the key form drawn in reverse. The children were told to look at the key form, then to look along

the same line until they found another exactly the same and to draw a line around it when they found it There were three practice and ten test forms. The second, or Word Perception Test, was constructed in a similar manner The words were printed in large, black type. The reversed word had the letters printed in reverse order and so was not the exact mirrored opposite of the key word. The other words in each line were words known to be easily confused with the key word There were two practice and fifteen test words. There were no time limits for either test, all children being given sufficient time to finish the whole exercise.

The above tests present several desirable features In the first place, ability to read was not necessary in order to do them successfully. Several papers were spoiled, however, through the inability of some children to follow directions. It should be noted that the kindergarten children had had no instruction in reading, but the first-grade children had had lessons in reading from the middle of September, the experiment being carried out in the beginning of the following January. To what extent this training has affected the results of the word test cannot be determined, but it makes the results all the more interesting Another important feature is that it is very unlikely that any of the children had had any previous experience with the type of geometric forms used in the form test This makes this test an interesting check on the word test

Since the number of pupils, particularly kindergarten pupils, was not very large, all usable scores were retained It was very rare, however, for any child to spoil both tests. It is believed that the numbers are large enough to indicate definite trends.

Table 2 reveals the almost universality with which the kindergarten children selected reversals. The number of first-grade pupils who made the same type of error, although distinctly less than that of the kindergarten pupils, is nevertheless strikingly large. The fact that there is a much bigger difference between first-grade and kindergarten pupils in the word test may be partly due to the fact that the first-grade children had had instruction in reading, so many of the words were already known to them, and also to the fact that the writer had frequently urged the teachers to emphasize the correct left-to-right eye-movements when presenting new words. In view of this the fact that 33% of the first-grade children selected reversed words is impressively large. It is interesting to note that

TABLE 2

PERCENTAGE OF KINDERGARTEN AND FIRST-GRADE PUPILS SELECTING ONE OR MORE REVERSALS

46	out	of	49	or	93.9%	kgn	pupils	select	one or more reversed forms
69	out	of	112	or	61.6%	gr 1	"	"	" " " " "
38	out	of	46	or	82.6%	kgn	pupils	select	one or more reversed words
40	out	of	122	or	32.8%	gr 1	"	"	" " " " "
34	out	of	41	or	82.9%	kgn	pupils	select	both reversed forms and reversed words
2	"	"	"	"	4.9%	"	"	"	no reversals at all
5	"	"	"	"	12.2%	"	"	"	reversed forms but not reversed words
0	"	"	"	"	0.0%	"	"	"	reversed words but not reversed forms
21	out	of	112	or	18.7%	gr 1	pupils	select	both reversed forms and reversed words
33	"	"	"	"	29.5%	" "	"	"	no reversals at all
48	"	"	"	"	42.8%	" "	"	"	reversed forms but not reversed words
10	"	"	"	"	8.9%	" "	"	"	reversed words but not reversed forms
55	out	of	153	or	35.9%	total	pupils	select	both reversed forms and reversed words
35	"	"	"	"	22.9%	"	"	"	no reversals at all
53	"	"	"	"	34.6%	"	"	"	reversed forms but not reversed words
10	"	"	"	"	6.5%	"	"	"	reversed words but not reversed forms

TABLE 3

PERCENTAGE OF TOTAL ERRORS WHICH REVERSAL ERRORS COMPRISE

46	kgn	pupils	made	105	reversal	errors	out	of	156	total	form	errors	or 67.3%
110	gr I	"	"	139	"	"	"	"	189	"	"	"	" 73.5%
156	total	"	"	244	"	"	"	"	345	"	"	"	" 70.7%
44	kgn	pupils	made	146	reversal	errors	out	of	316	total	word	errors	or 46.2%
119	gr 1	"	"	97	"	"	"	"	245	"	"	"	" 39.6%
163	total	"	"	243	"	"	"	"	561	"	"	"	" 43.3%

of the 153 pupils for whom scores on both tests are available 35% made both form and word reversal errors while only 22% made no reversal errors at all It would seem from this table, therefore, that it is a common thing for unselected young children to make reversal errors and that the number of children who make this type of error decreases with increasing age.

Table 3 shows that 70% of the total number of errors made in the form test and 43% in the word test were reversal errors This is strikingly large. The first-grade pupils made more reversal errors in the form test than did the kindergarten children, while the opposite is true on the word test It is interesting to keep in mind that there was only one reversal in each line of the test while there were three other incorrect forms, so that chance selection was not in favor of the reversal type of error

TABLE 4
PERCENTAGE OF PUPILS MAKING REVERSAL AND OTHER ERRORS BY CA GROUPS

CA range	N	Form errors Reversals	Form errors Other types	N	Word errors Reversals	Word errors Other types
5-0 to 5- 5	12	83.3	50 0	15	80.0	93.3
5-6 to 5-11	38	83 3	42 1	36	58 3	77 8
6-0 to 6- 5	36	72.2	41 7	37	24.3	62 2
6-6 to 6-11	39	66 6	35.9	41	48 8	70 7
7-0 to 7- 5	16	62.5	31 2	17	41.2	52 9
7-6 to 7-11	8	50 0	12 5	8	12.5	50 0
8-0 to 8-11	7	57.1	14 3	9	44 4	44.4

TABLE 5
PERCENTAGE OF PUPILS MAKING REVERSAL AND OTHER ERRORS BY MA GROUPS

MA range	N	Form errors Reversals	Form errors Other types	N	Word errors Reversals	Word errors Other types
4-0 to 4-11	9	88 9	100.0	8	75.0	100 0
5-0 to 5- 5	13	100 0	61 5	14	85 7	92 8
5-6 to 5-11	24	66 7	50 0	27	62 9	85 2
6-0 to 6- 5	30	76.7	33 3	35	45.7	74 3
6-6 to 6-11	34	70 6	26 5	33	30 3	51.5
7-0 to 7- 5	28	71 4	25 0	28	28 6	42 9
7-6 to 7-11	12	58.3	25 0	12	25.0	83 3
8-0 to 8-11	5	0 0	0.0	5	40 0	40 0
9-0 to 9-11	1	0 0	100 0	1	0 0	0 0

Tables 4 and 5 show that the number of form reversal errors decreased consistently with increased chronological age and word reversal errors with increased mental age.

TABLE 6

Correlations of CA, MA, and IQ with Reversals and Other Types of Errors

CA and form reversals	—.176±.052
CA and other form errors	—.228±.051
CA and word reversals	—.269±.048
CA and other word errors	—.337±.046
MA and form reversals	—.312±.049
MA and other form errors	—.420±.049
MA and word reversals	—.409±.044
MA and other word errors	—.488±.040
IQ and form reversals	—.122±.053
IQ and other form errors	—.236±.051
IQ and word reversals	—.152±.052
IQ and other word errors	—.151±.052

To make the data of Tables 4 and 5 clearer the correlations presented in Table 6 were calculated. The largest correlations were found to be those with mental age, all of them being significant. The correlations of the word test with CA, although smaller, are also significant. The fact that the correlations of reversal errors are smaller than these for other types of errors is probably due in part to the fewness of the former errors, there being greater opportunity for making other types of errors as has already been pointed out. The difference in the length of the two tests probably also affected the size of the corresponding correlations. From these figures it seems reasonable to conclude that the number of word reversals made by young children decreases distinctly with increasing mental age.

Tables 7, 8, and 9 show the average number of errors per pupil

TABLE 7

Average Number of Errors per Pupil

	Form errors			Word errors		
Pupils	N	Reversals	Others	N	Reversals	Others
Kgn	46	2.3	1.1	44	3.3	3.9
Grade 1	110	1.3	0.5	119	0.8	1.2
Total	156	1.5	0.6	163	1.5	1.9

TABLE 8

AVERAGE NUMBER OF ERRORS PER PUPIL BY CA GROUPS

CA range	N	Form errors Rever-sals	Form errors Others	N	Word errors Rever-sals	Word errors Others
5-0 to 5- 5	12	2.2	0.8	15	2.7	3.7
5-6 to 5-11	38	1.8	1.0	36	2.6	3.0
6-0 to 6- 5	36	1.5	0.7	37	0.7	1.3
6-6 to 6-11	39	1.5	0.4	41	1.4	1.7
7-0 to 7- 5	16	1.0	0.5	17	0.8	1.2
7-6 to 7-11	8	1.4	0.1	8	0.4	0.9
8-0 to 8-11	7	1.1	0.1	9	1.0	1.0

TABLE 9

AVERAGE NUMBER OF ERRORS PER PUPIL BY MA GROUPS

MA range	N	Form errors Rever-sals	Form errors Others	N	Word errors Rever-sals	Word errors Others
4-0 to 4-11	9	2.3	2.2	8	3.5	3.9
5-0 to 5- 5	13	2.6	1.2	14	3.2	5.0
5-6 to 5-11	24	1.5	1.0	27	2.2	3.2
6-0 to 6-5	30	1.6	0.5	35	1.7	1.4
6-6 to 6-11	34	1.6	0.4	33	0.9	1.1
7-0 to 7- 5	27	1.4	0.4	28	0.4	0.8
7-6 to 7-11	13	1.0	0.2	12	0.6	1.4
8-0 to 8-11	5	0.0	0.0	5	0.4	0.8
9-0 to 9-11	1	0.0	1.0	1	0.0	0.0

This is seen to be quite small but nevertheless is of importance. There is seen to be a fairly consistent decrease in the number of errors made with increasing mental age. The average number of both form and word reversal errors appears to decrease distinctly at the mental age of 5½ years and the word reversal errors again decrease distinctly at the mental age of 6½ years, but not so the form reversal errors. The decrease for both form and word reversal errors with increasing chronological age is not so clear, but there seems to be a distinct decrease in word reversal errors between 6 and 7 years chronological age. In this connection it is interesting to note that Rice (22, 39) found that the majority of children of 6½ years of age were able to recognize the correct orientation of drawings of spoons and diamonds but were confused between 5 and 6 years of age. Inasmuch as these children had had no experience with the geometric forms used in the Form Perception Test,

and there seems to be a distinct decrease in the number of reversal errors at the mental age of 5½ years, it would seem that this mental age is an important one in the development of the power to recognize the correct orientation of a form or word

Monroe (28) and others have reported that many more boys than girls present serious reading difficulties These data were analyzed to see if they would throw any light on this important problem. The results are presented in Tables 10, 11, 12, and 13.

Since practically all the kindergarten children made reversal errors,

TABLE 10

COMPARISON OF BOYS AND GIRLS WITH REGARD TO CA, MA, AND IQ

	CA		MA		IQ	N
Boys of kgn and grade 1	6 yrs	5.1 mos.	6 yrs.	3 99 mos	99 73	90
Girls of kgn. and grade 1	*6 yrs.*	*4.9 mos*	*6 yrs.*	*5 25 mos*	*101 44*	*80*
Boys of grade 1	6 yrs	8 9 mos.	6 yrs	6 5 mos	98.3	66
Girls of grade 1	6 yrs	7 8 mos	6 yrs.	8 9 mos.	102 66	54

TABLE 11

PERCENTAGE OF GRADE 1 BOYS AND GIRLS SELECTING ONE OR MORE REVERSALS

40 out of 61 boys or 65 6% select one or more reversed forms
28 out of 49 girls or 57.1% select one or more reversed forms
24 out of 66 boys or 36 4% select one or more reversed words.
14 out of 53 girls or 26 4% select one or more reversed words

TABLE 12

AVERAGE NUMBER OF REVERSAL AND OTHER ERRORS PER BOY AND GIRL BY GRADES

	Boys Form errors		Boys Word errors		Girls Form errors		Girls Word errors	
	Rever-sals	Others	Rever-sals	Others	Rever-sals	Others	Rever-sals	Others
Kgn.	2 54	0 91	3 77	4 68	2 22	1.25	3 17	3 17
Grade 1	1 15	0.43	0 77	1 38	1 38	0.48	0 87	1 08

TABLE 13

AVERAGE NUMBER OF TOTAL ERRORS MADE BY BOYS AND GIRLS

Boys made an average of 2 07 form errors
Girls made an average of 2.43 form errors
Boys made an average of 3 72 word errors
Girls made an average of 3.31 word errors.

Table 11 is confined to first-grade children From Table 10 it is seen that the first-grade girls tended to be brighter than the first-grade boys, so it is a little difficult to interpret Table 11 According to the latter table 10% more boys than girls made word reversal errors and 8% made more form reversal errors. This difference, although not large, seems somewhat significant Comparing the average number of errors made by each boy and girl it is seen from Table 12 that, although the average number of reversal errors tended to be greater for the kindergarten boys than for the kindergarten girls, this did not hold true for the first-grade boys, the first-grade girls, if anything, making slightly more reversal errors From Table 13 it is seen that the girls made more form errors and the boys more word errors

The above figures are not at all conclusive but they suggest the possibility of a sex difference in the field of word perception Should future studies bear out this indication then the reason so many boys fail to learn to read successfully can be explained in terms other than those currently prevailing, namely, that boys are more active and less docile than girls

Summary and Conclusions

This experiment was undertaken to test the writer's theory, based on an earlier study, that it is a natural phenomenon for very young *children to read words backwards and that they learn to perceive* words as adults do as a result of increasing maturity and experience

Two tests, a Form Perception and a Word Perception Test, were given to an unselected group of 50 kindergarten and 120 first-grade pupils. The distribution of intelligence of these pupils proved to be a very normal one.

The results revealed that practically all kindergarten and a significantly large percentage of first-grade children selected one or more reversed forms and reversed words There was a distinct decrease in the number of children making reversal errors and in the number of errors made by each child with increasing chronological age and mental age. These facts would fit in with a genetic theory of form perception.

That young children recognize objects, pictures, drawings, and letters independently of their orientation in space has been mentioned by several writers That words are also recognized without

regard to their absolute spatial position appears to be indicated by these findings. This would mean that words must have a very definite pattern and are probably recognized as wholes There are exceptions to this, however, for a few children were observed to match words letter by letter.

Bowden (1), Fildes and Myers (15), and the writer have observed that some children can recognize words presented upside down with surprising ease. This needs to be studied by experimental means It would have to hold true if the theory that words are recognized without regard to their orientation in space is a sound one.

If further investigation substantiates the above findings then Orton's theory of the lack of cortical dominance will hardly be adequate to explain the reversal type of error. There is the possibility, of course, that all reversal errors are not due to the same cause, and one would want to know at what age cortical dominance generally becomes established It is believed, however, that many cases of so-called reading disability can be avoided by making use of the above findings in the classroom

This study reveals, also, that an appreciably larger percentage of boys than girls made reversal errors, and the boys made a higher average of total word errors than did the girls. This seeming sex difference in the field of word perception is somewhat obscured by the fact that the boys were slightly duller than the girls and is in need of further investigation The above findings, however, have implications for the classroom.

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UNE ÉTUDE DES ERREURS RENVERSÉES FAITES PAR LES PETITS ENFANTS

(Résumé)

On a fait cette expérience dans le but de déterminer le degré auquel les petits enfants non selectionnés font le type d'erreur soi-disant renversée à laquelle on a fait tant d'attention dans l'étude des incapacités dans la lecture.

On a fait deux tests, un test de Perception de Forme et un test de Perception de Mots. Les deux ont été de construction similaire et du type choix multiple Il a fallu aux enfants trouver une forme géométrique similaire à une forme géométrique donnée. Ils ont eu un choix de cinq formes, l'une étant la même que la forme donnée et l'une la contraire Le test de mots de même.

Ces tests ont été soumis à 50 enfants du jardin d'enfants et à 120 élèves de première année de l'école élémentaire dont la distribution de l'intelligence basée sur les QI's Stanford Binet a été très normale

On a constaté qu'à peu près tous ceux du jardin d'enfants et un pour-

centage plus petit mais assez grand pour être signifiant des élèves de première année ont fait des erreurs renversées. Le nombre des enfants qui ont fait des erreurs renversées a définitivement diminué avec l'avancement de l'âge mental. Il paraît que cette tendance à faire des erreurs renversées est un phénomène naturel chez les petits enfants Il y a eu aussi quelques indications d'une différence de sexe, puisqu'un plus grand pourcentage des garçons de première année a fait des erreurs renversées que le pourcentage des filles de même année.

DAVIDSON

EINE UNTERSUCHUNG DER VERTAUSCHUNGEN BEI JUNGEN KINDERN

(Referat)

Dieses Experiment wurde vorgenommen, um festzustellen, zu welchem Grade unausgewahlte junge Kinder den Vertauschungstyp von Irrtum (reversal type of error) begehen, dem so viel Aufmerksamkeit bei der Untersuchung der Leseunfahigkeiten zugewandt worden ist.

Zwei Tests wurden aufgestellt Ein Formwahrnehmungstest und ein Wortwahrnehmungstest Beide waren ahnlich im Bau und von der Art der vielfachen Wahl (multiple choice). Die Kinder sollten eine geometrische Form finden, die einer gegebenen geometrischen Form ahnlich war Sie hatten die Auswahl von funf Formen, deren eine identisch und die andere das Gegenteil der gegebenen Form waren Aehnlich bei dem Worttest

Diese Tests wurden 50 Kindern des Kindergartens und 120 der ersten Stufe (first grade) gegeben, deren Intelligenzverteilung auf Grund des Stanford-Binet Tests sehr normal war

Es wurde festgestellt, dass fast alle Kinder des Kindergartens und ein kleinerer aber bedeutsam grosserer Prozentsatz der Kinder der ersten Stufe Vertauschungsirrtumer machten Es gab eine deutliche Abnahme bei einer Zunahme der Intelligenz der Anzahl der Kinder, welche Vertauschungsirrtumer machten Diese Neigung, Vertauschungsirrtümer zu machen, scheint ein naturliches Phanomen bei jungen Kindern zu sein. Eine Andeutung eines Geschlechtsunterschiedes stellte sich heraus; ein grosserer Prozentsatz der Knaben der ersten Stufe machte Vertauschungsirrtümer als die Madchen.

DAVIDSON

THE READING AND THE READING INTERESTS OF GIFTED CHILDREN*

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Despite the vital and extensive knowledge which has resulted from studies of gifted children during the last decade by Terman (21), Hollingworth (13), and others (2), many questions concerning the gifted are unanswered. This paper adds one fragment more to the rather imposing and extensive literature

Fifty children of IQ 140 or higher were identified by one of the writers in 1924-25 and each child was carefully studied. The group consisted of 26 boys and 24 girls All of the children were in grades III-VII when the original study was made (25). Follow-up information was secured from time to time, and in 1929-1930 a rather detailed study was again made The findings that were obtained during the five-year period (1924-1929) have been published (27). Herein we shall present additional information, obtained in 1931-1932, regarding the reading and the reading interests of the children

It was impossible in 1931-1932 to get in touch with all fifty of the children Forty of the gifted (20 boys and 20 girls) responded in 1931-1932 Before presenting the data regarding the reading and the reading interests of these children it may be well to acquaint the reader with some of the significant facts about the group.

When the children were first studied their mean chronological age was 10 years, 6 months In 1929 the average age of the children was 15 years, 6 months, and at the time of the most recent follow-up study, that of 1931-1932, the mean chronological age was 17 years, 6 months The gifted group have IQ's 148-185. The mean IQ of the entire group is 152, the means for the boys and girls fall in the same class interval, IQ 150-155

Typically, these gifted children have remarkably superior general

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mental ability Retests made after an interval of five years revealed that they had maintained their early mental superiority. Physicians found them to be at least equal physically to the control group of children of the same chronological ages; and in motor dexterity, they were somewhat superior They had emerged predominantly from English, Scotch, and Jewish stocks. With few exceptions they had had the advantages of stimulating cultural influences at home; and their lineage was marked by the presence of numerous personages of achievement and note. However, their educational progress was not commensurate with their mental superiority[1] Furthermore, it was evident from the results of the second testing, that of 1929-1930, that the school had not adjusted educational opportunity to these children's capacities Their achievement was most superior in the language arts; their poorest attainment was in the "drill" subjects. They were at least as energetic and as interested in play as were children of average mental ability According to teachers' and parents' estimates of character development as well as the results of character tests, the conduct of these children appeared better than that of mentally average children of similar chronological ages Their vocational choices corresponded more closely with their mental ability than did those of mentally average children The gifted participated generously in school life, and they carried more than their proportionate share of the school honors

Reading and Reading Interests

The reading and reading interests of the gifted children were originally studied by three methods (1) the children's reports, (2) teachers' estimates, and (3) parental statements

The children were asked three times during 1924-1925 and once only in 1929 and in 1932 to supply the following information:—

1 How many hours per week do you spend upon reading which is not assigned in school?
2 Mark the kinds of books you enjoy reading most Rank 1, 2, and 3 the types you like best The rank 1 is to be given to the best-liked type *Three types only* are to be ranked,

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[1]*The gifted children in this study* resemble strikingly those studied by Terman and Burks, (21a)

(a) Travel stories
(b) Biographies
(c) Novels (romance)
(d) Novels (home or school life)
(e) Novels (adventure)
(f) Science stories
(g) Short stories
(h) Detective stories
(i) Mystery stories
(j) Essays (general)
(k) Essays (comical or satirical)
(l) Myths or legends
(m) Music or art books
(n) Poetry

3 List the books you have read or have started to read *during the past week* (This information was requested upon a Monday)
4 List the magazines you are reading and state which ones you like best (Magazine reading was not studied in the 1924-1925 investigations)
5 State approximately the number of books you have read during the past two months.

Time Spent in Reading

As was stated above, five reports were obtained of the time spent by the gifted children in voluntary reading, three reports were obtained in 1924-1925, one in 1929, and one in 1932. Responses for the control group were included in the 1924-1925 and the 1929 reports. These two studies have been previously published (27).

TABLE 1
Time Spent by Gifted Children in Voluntary Reading

	Hours per week Mean	Range
Teachers' judgment of gifted group (1924)	8	2 -12
Teachers' judgment of control group (1924)	3	1 - 8
Parents' judgment of gifted group (1924)	9	2 -12
Teachers' judgment of gifted group (1929)	12	1 -16
Teachers' judgment of control group (1929)	5	0 - 6
Girls' report (1924)	6 5	1 -12
Boys' report (1924)	5 5	3 -14
Girls' report (1929)	8 0	0 5-20
Boys' report (1929)	7 5	1 0-25
Girls' report (1932)	9 5	1 -35
Boys' report (1932)	7 5	0 5-15

Table 1 sets forth the time spent in voluntary reading as reported both by the gifted and by the control groups at the time when the several studies were made. The data of the three reports were aver-

aged for 1924-1925. The close agreement of the estimates of the teachers and of the parents regarding the time spent in reading by the gifted children in 1924 is conspicuous; it is of interest also to note the marked difference in the alleged time devoted to reading by the gifted and by the control groups. According to the lowest estimate, that of the teachers in 1924, the gifted group averaged 8 hours per week, range 2-12 hours; the control group averaged 3 hours per week, range 1-8 hours. The weekly average of these gifted children (mean chronological age 10 years, 6 months) approached that of a group studied by Gray and Munroe, which had "less than high school" and more than eighth-grade education (12). Although the writers' gifted group approximated closely the Gray-Munroe group in the amount of time that they devoted weekly to reading, the control group did not approach this level. The foregoing comparison of the gifted is all the more significant when one recalls that at the time of the first investigation these youngsters were in grades III-VII.

The estimates of the teachers suggest that during the five-year interval, 1924-1929, there was a significant increase on the part of both the gifted and the control groups in the number of hours devoted per week to reading These findings corroborate those of other investigators (2, 5). In 1929 the gifted children were on the average 15½ years of age. Those who had continued their formal education were in high school, but none had been graduated. Nevertheless, the mean number of hours per week that they were devoting to reading was greater than the mean reported by the typical high school graduate in the Gray-Munroe study (12, p 35).

According to the 1932 reports the gifted girls spent on the average 9.5 hours, the boys 7 5 hours per week in reading One girl reported that she had devoted about 35 hours each week to voluntary reading; all reported that they had spent some time in spontaneous reading. Comparison of the results of the earlier studies with those of 1929 and 1932 reveals that with increased maturity there has been *an increase in the amount of reading done The height of the "reading craze" heralded by Terman and Lima as usual at about the age of 13 for the average child seems not to have been reached by these children. On the contrary, as they grow older the gifted children in this study become more and more fond of reading*

The data of all our reports suggest that the gifted girls devote more

time to reading than do the gifted boys. The following hypothesis may account in part for this finding. Several studies indicate that girls are more inclined to engage in sedentary activity than are boys Furthermore, the geographical range of activity participation appears to be greater for boys than for girls Boys, therefore, may seek less frequently the vicarious experience which reading affords

On the whole, the data in Table 1 show that the gifted group devoted considerably more time to voluntary reading than did the control group and that between the ages of 10½ and 17½ there has been a gradual increase in the time spent by the gifted children in reading.

Number of Books Read

Correlated with the amount of time spent in reading is the number of books read. Table 2 exhibits the number of books read by

TABLE 2
Books Read during the Past Two Months by Gifted Children (1932)

	Mean number	Range
Girls	8	0-27
Boys	6	0-14

the gifted during a two-months interval. The girls averaged 8 books, range 0-27, the boys averaged 6 books, range 0-14. One boy and two girls reported that they had read no books during this two-months interval These individuals had, however, spent some time in other kinds of reading. One boy and one girl included a notation on their report blanks to the effect that, much as they would have liked to do a great deal of reading, both school and outside work rendered this impossible. The gifted boys and girls were at this time of late high-school and junior-college age Terman and Lima assert that "the average college freshman reads not a single book beyond the requirements laid down by his instructors" (22, p 28) The data for our gifted group stand out in sharp contrast to those for unselected college freshmen.

TABLE 3
Books Read or Started during the Past Week by Gifted Children (1932)

	Mean number	Range
Girls	3 3	0-7
Boys	1 9	0-5

The girls devote not only more time to reading than do the boys, but they read also a larger number of books Table 3 presents the figures concerning reading for a single week. Terman (2, 22), Hollingworth (13), and Johnson (17)—studying unselected school children in regard to the relation of sex to reading interests—have set forth corroborative evidence However, the number of books read does not tell the whole story regarding the reading interests of the gifted boys, since the latter read both magazines and newspapers more frequently than did the gifted girls

Significant studies of the number of books read by unselected school children in the various grades have been made by Terman and Lima (22), and by Smith (20) These studies are of importance here inasmuch as they afford a basis for comparing the books read by the gifted with those of different school-grade groups Terman and Lima studied the reading of 808 unselected school children of ages 6 to 16 in three small California cities. They observed that the "averages are somewhat higher than would be found over the nation at large, but are fairly representative of the well-to-do community where good libraries are the rule rather than the exception." The children that were studied by Terman and Lima read the maximum number of books per week at about age 13. Although the average age of our gifted groups was 17½ when the 1932 report was obtained, no pinnacle beyond which there is a *diminution in reading seemed to have been reached.*

Kind of Reading Most Enjoyed

Table 4 presents the types of books liked best by the gifted boys and girls as reported in 1924-1925, 1929-1930, and 1931-1932 The preferences of the boys in 1924-1925 and 1929-1930, although they exhibit some changes in interest, were on the whole similar ($r = +62$) Novels of adventure, novels of romance, and science stories were best liked by them, while myths and legends, poetry, and music and art books were least liked During the eight-year interval however (1924-1932), there was a marked change in type of interest ($r = +19$). Science stories, short stories, and biography have now come to be preferred, but the types that were least liked in 1924-1925 remain somewhat constant. With increasing maturity, the boys have shifted their emphasis to those types of reading which may be categorized as practical and serious.

TABLE 4
KIND OF READING ENJOYED MOST BY GIFTED CHILDREN

Type of book	Boys' ranks (1924-25) Age 10½	(1929-30) 15½	(1931-32) 17½	Girls' ranks (1924-25) 10½	(1929-30) 15½	(1931-32) 17½
Novels (adventure)	1	1	4	3	3	4 5
Novels (home or school life)	12	11	13	2	2	4 5
Novels (romance)	4	2	10	1	1	2
Detective stories	5	10	7	4	15	6
Mystery stories	2	9	10	5	6	9
Science stories	3	3	1	15	- 14	0
Biographies	6	4	3	9	12	11
Myths and Legends	13	12	10	6	7	11
Essays (general)	7	5	0	10	4	11
Essays (comical or satirical)	15	6	5 5	14	8	7 5
Autobiographies	8	7	8	13	9	0
Short stories	9	13	2	7	13	3
Poetry	10	14	13	12	5	1
Drama	11	8	0	11	10	0
Music and art books	14	15	13	8	11	0

With the gifted girls as with the boys we find some similarity between the preferences of 1924-1925 and those of 1929-1930 ($r = +.44$). Most popular among the girls on both occasions were the novels of adventure, novels of home or school life, and of romance. Least liked by the girls were science stories, biographies, autobiographies, and comical or satirical essays. In 1931-1932 the gifted girls gave first rank to poetry and second rank to romantic novels. On the whole, the data for 1932 reveal a tendency on the part of both the boys and the girls toward concentrating interest in fewer types of books. When the gifted children were first studied many types of stories were preferred, but in 1932 fewer types of stories were distinctly preferred.

The sex differences among the gifted children, evidenced by preference for types of reading, paralleled those of unselected boys and girls (17, 18, 23). These sex differences are pronounced. The older boys prefer novels of adventure, short stories, science stories, and biography The older girls prefer novels of romance, and poetry. Terman's findings coincide with the foregoing findings for the boys but they are at variance in that they include the drama among the types best liked by the girls. Local conditions may be one of several reasons for this discrepancy Jordan, studying the reading interests of unselected children, arrived at conclusions with respect to sex differences similar to those in this study (18).

It is not without significance that among the gifted children little interest was exhibited in the books dealing with the fine arts, with music, and with the drama And with the boys poetry also is accorded little or no interest. Small wonder then that newspapers and "middle-grade" magazines absorb practically the whole of the leisure time that the average adult devotes to reading (26)! Certainly the data regarding the reading interests both of gifted children and of adults cannot be regarded otherwise than as a serious reflection upon the effectiveness of the school in instilling and developing permanent worth-while interests in reading as a leisure activity Although the voluntary reading of the gifted child is *relatively* high in quality and in amount, it appears by no means to be all that is needed for bringing about maximum growth and development through the reading of these promising children. Several important fields of human endeavor are untapped by their present reading practices, and the liberalizing effect of reading in the arts is conspicuously absent Herein, we find an opportunity for guidance that may prove fruitful

The Most Popular Books Among the Gifted Boys

Tables 5, 6, and 7 reveal the titles of the books most frequently read by the gifted boys at the various times reports were obtained.

TABLE 5

Ten Most Popular Books Reported by Gifted Boys of Age 10½ (1924-25)

Name of book	Author
Huckleberry Finn	Clemens
Treasure Island	Stevenson
Twenty-Thousand Leagues Under the Sea and Other Stories	Verne
Mystery Stories	Poe
Americanization of Edward Bok	Bok
Life of David Crockett	Crockett
Autobiography	Franklin
The Pathfinder	Cooper
Roughing It	Roosevelt
All About Electricity	Knox

TABLE 6

Ten Most Popular Books Reported by Gifted Boys of Age 15½ (1929-1930)

Name of book	Author
Ivanhoe	Scott
Royal Road to Romance	Halliburton
The Glorious Adventure	Halliburton
Where the Blue Begins	Morley
Mystery novels	Various authors
The Story of Philosophy	Durant
Revolt in the Desert	Lawrence
Story of a Bad Boy	Aldrich
Sentimental Tommy	Barrie
Sorrell and Son	Deeping

TABLE 7

Ten Books Selected at Random from List Reported by Gifted Boys of Age 18½ (1931-1932)

Name of book	Author
Toilers of the Sea	Hugo
Selected Poems	Kipling
Creative Chemistry	Slosson
Pluck and Luck	Benchley
Kenilworth	Scott
Myron T. Herrick	Mott
The Good Earth	Buck
Little Caesar	Burnett
Memoirs of Cassanova	Cassanova
The Executive and His Control of Men	Gowin

The titles of 1924-1925 reflect marked interest in stories of action and adventure. These books are of a high type, however, the kind considered desirable for boys about 11 or 12 years of age Tables 5 and 6, the latter representing the dominant literary tastes of the boys after a lapse of five years, reveal not only a good miscellany of authors and titles, but also a salutary development of the boys' interests The reports of both periods suggest a fairly high type of interest both in authors and titles, but those of the second period are distinctly superior in quality to those of the former

In 1931-1932 only two books were reported more than once by the boys. These were *Pluck and Luck,* by Benchley, and *Toilers of the Sea,* by Hugo. In the first two investigations certain books were cited frequently enough to enable one to select the ten most popular books. Although in 1932 the gifted boys had come to prefer fewer types of books, they appeared to have broadened in making their selections within these fields Consequently, it is impossible to list the ten books that were most popular among the boys in 1932

Table 7 shows the books selected as representative of the character of the reading done by the gifted boys in 1931-1932. Unquestionably the complete list transcends in quality those that were obtained earlier Every title that is listed in Table 7 has at one time or other been acclaimed worthwhile (4, 9).

THE MOST POPULAR BOOKS AMONG THE GIFTED GIRLS

Tables 8, 9, and 10 present the books reported as most popular by the gifted girls in 1924-1925, in 1929-1930, and in 1931-1932 As in the case of the boys' lists, these represent almost uniformly an

TABLE 8

TEN MOST POPULAR BOOKS REPORTED BY GIFTED GIRLS OF AGE 10½ (1924-1925)

Name of book	Author
Little Women	Alcott
Hans Brinker	Dodge
The Prince and the Pauper	Clemens
Treasure Island	Stevenson
Jungle Book	Kipling
Vanity Fair	Thackeray
Seventeen	Tarkington
Home Book of Verse	
Jeremy	Walpole

TABLE 9

Ten Most Popular Books Reported by Gifted Girls of Age 15½ (1929-1930)

Name of book	Author
The Green Bay Tree	Bromfield
Poetry	Millay
The Crisis	Churchill
Royal Road to Romance	Haliburton
The Scarlet Letter	Hawthorne
One Increasing Purpose	Hutchison
Color	Cullen
"We"	Lindbergh
Sorrel and Son	Deeping
Glorious Apollo	Barrington

TABLE 10

Ten Books Selected at Random from List Reported by Gifted Girls of Age 17½ (1931-1932)

Name of book	Author
The Shadow on the Rock	Cather
Forsythe Saga	Galsworthy
An American Tragedy	Dreiser
The Good Earth	Buck
Plays	Shakespeare
Mill on the Floss	Eliot
The Light that Failed	Kipling
Devils, Drugs, and Doctors	Haggart
Death and Taxes	Parker
Rivers to the Sea	Teasdale

excellent array of first-class authors and titles. No great difference is readily discernible between the quality of the girls' list of 1924-1925 and that of 1929-1930. However, the books in the latter list exemplify greater diversity of interest than do those in the former Here, as in the case of the boys (with the two exceptions noted for the latter), the reports of 1931-1932 presented no book which was mentioned more than once.

Concluding Remarks

Several investigators have found (as this report indicates) that the measurable scholastic attainment of mentally superior children is not commensurate with their ability as measured by objective mental tests If one accepts the view that education is a series of

experiences,[2] this finding is of less importance than it appears at first appraisal In other words, this result fails to tell the whole story with reference to the gifted child The broader view of education as a process encompassing *all* experience should enable us to realize that *the gifted child is not pursuing the same curriculum as is the mentally average child* By his extensive reading, he has been making his own curricular differentiation and the ordinary school examination has probably failed to measure adequately the difference in outcome.

What then is the outcome of these gifted children's extensive reading? And what is the actual (entire) attainment of the gifted as compared with the mentally average child? Full answers to the foregoing queries are obviously lacking This study has revealed some activities not ordinarily taken into account by the school; it contributes something therefore to the knowledge of the broader education which the gifted child is obtaining However, it appears that the school can help greatly to enrich the gifted child's experience by providing him with opportunity to read *the best* of those books which are appropriate to his particular age level

Within recent months there has been much discussion of the "new leisure," the prospect of ever-increasing leisure, and the need of preparing individuals to employ their leisure in desirable ways (19a). By acquainting the gifted child with worth-while books, the school can aid in raising his standards of reading enjoyment, thus encouraging him to participate in a worth-while leisure-time pursuit. The data that are presented in the present paper indicate some of the books which gifted children within certain CA limits prefer to read; this preferred voluntary reading points to the need of guidance which will engender one kind of curricular enrichment for the gifted child

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[2]Unzicker has expressed this point of view quite clearly in the following statement —"In the light of modern psychology, what is the curriculum? Let it be emphatically stated that the curriculum is not merely a printed course of study, it is not merely a syllabus, it is not merely a program of studies Nor is it a textbook nor any series or set of textbooks. The curriculum is not so simple nor so detached from the pupil as are all these externalities More properly and more accurately, the curriculum may be considered as all those activities in which the pupil engages and as the result of which changes occur and growth takes place within the individual" (22a).

Summary

Fifty children of IQ 140 or higher were identified by one of the writers in 1924-1925 and each child was carefully studied. Follow-up information was secured from time to time and in 1929-1930 a detailed study was again made. The present paper contains additional information, obtained in 1931-1932, regarding the reading and the reading interests of the children. At age 10½ the gifted children spent as much time per week in reading as did the Gray-Munroe unselected group that had "less than high school" but more than eighth-grade education. At age 15½ the children devoted more time to voluntary reading than did the typical unselected high-school graduate. At age 17½, the time of the latest reports, no pinnacle beyond which there is a diminution in reading seemed to have been reached. The height of the "reading craze" heralded by Terman and Lima as inevitable at about the age of 13 for the average child seems not to have been reached by these children.

Among other findings are the following. The gifted participate generously in school life, and they carry more than their proportionate share of the school honors. The gifted girls consistently read more books than did the gifted boys. However, the boys read magazines and newspapers more frequently than did the girls. During the eight-year interval (1924-1932) there was a marked change in the reading interests of both boys and girls. On the whole, the data for 1932 reveal a tendency on the part of both sexes toward concentration of interest in favor of fewer types of books. In general the sex differences among the gifted, as regards choice of types of reading, resemble those of unselected children. Among the gifted children little interest was exhibited in the books dealing with the fine arts, with music, and with the drama.

Tables are employed herein to present the kinds of voluntary reading enjoyed most by the gifted girls and the gifted boys at three different age levels, e.g., age 10½, age 15½, and age 17½. The most popular books are likewise listed according to sex and chronological age. Brief interpretations of the findings are set forth and several pedagogical applications are suggested.

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LA LECTURE ET LES INTÉRÊTS DANS LA LECTURE CHEZ LES ENFANTS BIEN DOUÉS

(Résumé)

Cet article présente une description détaillée de la lecture et des intérêts dans la lecture chez 50 enfants bien doués qu'on a identifiés en 1924-25, et qui ont été les sujets de quelques études génétiques pendant les années suivantes. Un court résumé présente des données à l'égard des traits physiques, mentaux, et sociaux du groupe. On trouve après des rapports sur, (1) Le temps consacré à la lecture, (2) les types de livres préférés, et (3) les noms des livres et des revues lus le plus fréquemment. On compare ces données (obtenues en 1931-32) avec des données semblables obtenues en 1924-25, et en 1929-30 D'ailleurs, on compare ces résultats avec ceux des autres études de la lecture des enfants bien doués et des enfants normaux La qualité supérieure de la lecture des bien doués se montre clairement, et la quantité de la lecture devient de plus en plus grande comme les enfants deviennent plus âgés. Bien que les enfants soient maintenant agés en moyenne de 17 ans, six mois, ils n'ont pas encore atteint une hauteur après laquelle il se trouve une plus petite quantité de lecture

WITTY ET LEHMAN

DAS LESEN UND LESEINTERESSEN BEGABTER KINDER

(Referat)

Dieser Aufsatz stellt eine eingehende Beschreibung des Lesens und der Leseinteressen von 50 begabten Kindern dar, die in 1924-25 identifiziert wurden und die als Versuchpersonen fur genetische Untersuchungen wahrend der folgenden Jahre gedient haben Eine kurze Zusammenfassung gibt die Einzelheiten uber die physikalischen, geistigen, und sozialen Eigenschaften der Gruppe Berichte folgen uber (1) Die Zeit, die zum Lesen verwendet wird, (2) Die Arten von Buchern, die vorgezogen werden, und (3) Die Namen der Bucher und Zeitschriften mit ahnlichen Daten, die aus den Jahren 1924 25 und 1929-30 erhalten wurden Ausserdem wurden diese Ergebnisse mit denen der anderen Untersuchungen des Lesens von begabten und normalen Kindern verglichen Die uberlegende Qualitat des Lesens der begabten Kinder ist sichtbar, und die Quantitat des Lesens nimmt daurend zu, als die Kinder anwachsen Obgleich die Kinder jetzt im Durchschnitt 17 Jahre sechs Monate alt sind, haben sie nicht den Gipfel erreicht, hinter dem es eine Abnahme der Quantitat des Lesens gibt

WITTY UND LEHMAN

SHORT ARTICLES AND NOTES

A MULTIPLE-FACTOR ANALYSIS OF CERTAIN MEASURES OF ACTIVENESS IN NURSERY SCHOOL CHILDREN

HELEN LOIS KOCH

In an earlier paper (1) concerned with the problem of the predictability of the relative activeness of children in various types of occupations from their behavior in other types, we reported that for the group and activities investigated the variance in activeness seemed to be a function, in part, of factors unique for the different occupations. We obtained, for example, measures of the activeness of the fifty members of a group of nursery school children in nine different kinds of activities occurring in the nursery routine The correlations between these measures were, in the main, low, +.52 being the highest, while the majority of the coefficients fell between +.20 and +.40. Since these intermeasure correlations were usually considerably lower than the reliability coefficients computed in various ways, the small r's did not seem to be the result of error factors entirely. We were inclined, hence, to surmise, as stated above, that influences specific to the occupations were tending to determine to a degree worth considering the activeness the children displayed.

The fact, on the other hand, that with three exceptions the intermeasure correlations (see Table 4 in our earlier study) were positive stimulated us to attempt to discover whether such coefficients as we did obtain could be viewed as the expression of a single factor, activeness, in the sense in which Spearman uses the term "factor" Applying the tetrad-difference method and finding that the tetrads did not tend to vanish, we concluded that one factor could not account for the entries in our correlation matrix After we had probed somewhat further with a partial correlation procedure, which we now feel was misused and which at best was not very workable, the analysis was given up as hopeless The development by Thurstone of a multiple-factor analysis method, however, has now placed in our hands a tool of the sort we have needed and has caused us to revive our efforts

We have employed in the analysis we are to describe the Thurstone centroid method (2), as well as procedures developed by him for the plotting of factor data and the selection of axes for reference. It appears from the first step in the analysis that three major[1] common factors, in addition to the specific and error factors we mentioned earlier, will account for most of the pattern of our original findings The correlation residuals when the three common factors have been extracted are relatively small,

[1]We are using here Thurstone's, not Spearman's, terminology

all falling within the range of the probable errors of the correlation coefficients

The factor weights obtained by the centroid procedure to which we have referred are set forth in the second, third, and fourth columns of Tables 1 and 2 Since, however, the inspection of these weights gave us none too much information regarding the probable nature of the common factors, we attempted to track the scent further by augmenting the coordinates and rotating the axes as Thurstone[3] urges and by introducing an additional item, age, into the correlation matrix We thought that if maturity, or whatever that signifies in the way of integration or strength, is one of our common factors, then the item, age, should show a preponderance of this factor The original weights obtained from our correlation matrix which includes the item, age, are given in the second, third, and fourth columns in Table 2

Having three factors to deal with, we could represent our measures as points in a three-dimensional space To facilitate their description with respect to a new set of axes which might make them more meaningful psychologically, we have augmented the coordinates in such a way as to project each of the points to the surface of a sphere and have plotted the points Then, again by a centroid procedure, we have determined three planes orthogonal to each other and so placed as to make as many as possible of the points representing our nine measures fall on or very near them This procedure is guided by the aim to reduce to zero or insignificantly small quantities as many as possible of the factor weights expressed in terms of the new axes In his thinking about the concept of unitary ability Thurstone has developed this procedure

Since the number of measures we have dealt with is small, the centroid method employed for locating the orthogonal planes which will serve as the new axes is necessarily rough and will give us only an approximation The exact values of our measure coordinates cannot, hence, be taken too seriously They should, however, reveal the essential trends in our data

The common factor weights derived according to the Thurstone method of augmenting the original coordinates are presented in Tables 1 and 2, columns 7, 8, and 9; while those describing our measures in reference to the new axes mentioned earlier are to be found in columns 11, 12, and 13 Columns 15, 16, and 17 contain the unaugmented weights in terms of the new axes

The latter tend to lend support to our hypothesis that one of our common factors is either maturity or a quality such as strength which would behave as we might expect maturity to behave in the complex we are dealing with. The first factor, for example, has a weight of + 70 in the case

[3]A description of these procedures is to appear soon in an article by Dr Thurstone in the *Journal of General Psychology*

TABLE 1

FACTOR WEIGHTS—MEASURES OF ACTIVENESS ONLY

Activity	Original weights					Weights—augmented				Weights after rotation of axes—augmented				Weights after rotation of axes—unaugmented		
	Factor I	Factor II	Factor III	Commonalty (h)	Uniqueness (u)	Factor I	Factor II	Factor III	h^2	Factor I′	Factor II′	Factor III′	h^2	Factor I′	Factor II′	Factor III′
Pedal (indoors)	+73	+08	−09	74	.68	+99	+11	−12	1.00	+.66	+37	+66	1 00	+48	+27	+48
Floor	+58	−17	−22	64	77	+90	−.26	−34	99	+33	+66	+67	99	+.21	+43	+43
Table	+38	−29	−38	61	79	+62	−48	−62	1 00	+02	+90	+43	1 00	+01	+55	+.26
Circle (sitting)	+.40	−33	−.25	58	82	+70	−57	−45	1 00	−03	+79	+62	1 00	−02	+45	+36
Circle (standing)	+27	+58	+01	64	77	+42	+91	+02	1 00	+98	−17	−10	1 00	+62	−11	−07
Dressing-undressing	+57	+33	+02	66	75	+86	+50	+03	99	+.89	+10	+43	98	+.59	+06	+.28
Pedal (outdoors)	+.64	−23	+28	74	68	+87	−31	+38	1.00	+19	+03	+98	1 00	+14	+02	+72
Apparatus	+.55	+19	+17	61	80	+91	+31	+28	1 00	+73	−07	+68	1 00	+44	−.05	+41
Construction	+43	−40	+32	68	74	+64	−62	+48	1.00	−20	−03	+99	1 02	−14	−02	+.66

TABLE 2

FACTOR WEIGHTS—MEASURES OF ACTIVENESS AND AGE

Activity	Original weights					Weights—augmented				Weights after rotation of axes—augmented				Weights after rotation of axes—unaugmented		
	Factor I	Factor II	Factor III	Commonalty (h)	Uniqueness (u)	Factor I	Factor II	Factor III	h^2	Factor I′	Factor II′	Factor III′	h^2	Factor I′	Factor II′	Factor III′
Pedal (indoors)	+73	+01	+10	74	68	+99	+01	+14	1 00	+.75	+13	+65	1 00	+56	+09	+48
Floor	+.58	+06	−19	.61	79	+95	+10	−30	1 00	+71	+54	+46	1 01	+44	+33	+28
Table	+32	−30	−47	64	77	+50	−47	−73	1 00	−07	+86	+51	1 01	−04	+55	+33
Circle (sitting)	+35	−38	−10	53	85	+67	−72	−19	1 00	−02	+40	+92	1 01	−01	+.21	+48
Circle (standing)	+.30	+45	+31	63	78	+.48	+72	+50	1 00	+.91	−40	−12	1.00	+.57	−25	−08
Dressing-undressing	+69	+41	+15	82	.58	+.84	+51	+.18	1 00	+98	+.02	+19	1 00	+80	+02	+.16
Pedal (outdoors)	+60	−35	+28	75	66	+.80	−47	+.37	1 00	+33	−12	+.94	1 00	+25	−09	+70
Apparatus	+54	00	+16	56	83	+96	00	+28	1.00	+75	−02	+.67	1 00	+42	−01	+38
Construction	+40	−43	+07	59	81	+67	−73	+12	1 00	+.02	+10	+99	1.00	+01	+06	+59
Age	+47	+57	−15	76	65	+62	+76	−20	1.00	+.93	+.32	−22	1 00	+70	+24	−16

of the item, age, which we would point out is a none-too-good index of maturity. The factor appears to have been of practically no significance in determining the activeness of our subjects when they were indulging in hand work at a small table or engaging in the quieter games and exercises in which the whole group while seated participate together under the teacher's direction. It seems, on the other hand, to have determined to a considerable degree the variance in the children's activeness while they were dressing or undressing as well as while occupied in walking out of doors, free floor-play indoors, work with the play-yard apparatus and the vigorous games, marches, and dances, which we term circle-stand activities The reasonableness of our hypotheses regarding the nature of factor I', in the light of this total picture, it would take no high degree of imagination to appreciate

The second factor, apparently, is relatively unrelated to the activeness of the subject while he is walking or playing out of doors, weighing heavily only in the case of such activities as table work, quiet formal group play while seated, and free floor-play This factor, which is most conspicuous in the case of the item, table work, and very readily apparent in other occupations where movement is more or less restricted by the environment, we have envisaged as something akin to nervousness On the basis of other observations reported in our earlier paper we had reason to believe that nervousness or emotionality was entering into our results The children who were restless when they were supposed to be resting, for example, tended to be less active than the other subjects when opportunity was provided for vigorous free play The evidence for our hypothesis concerning the nature of factor II' is, of course, not so convincing as is that concerning the first factor

Factor III', it is our conjecture, is spontaneous activeness, though we could easily think of it as aggressiveness It would seem reasonable for such a factor to have little influence, as III' apparently does have, in the matter of behavior such as occurs in dressing activities or during group circle work—occupations in which the members are being constantly directed by others In all of the relatively undirected types of occupation factor III' has a positive weight of at least 26, while in the case of construction work and pedal activity out of doors, it is the only one of the common factors of any importance.

It is interesting that, with axes drawn as described, floor-play and pedal activity indoors are the only items which have a considerable amount of all three common factors in them It is worthy of comment, too, that the pedal patterns, indoor and out, are not distinctly similar, factor III' (spontaneous activeness?) playing a larger part in the child's walking behavior out of doors, while indoors, the first factor (maturity?) probably has the more conspicuous role. As far as common factors are concerned, table

work and circle-sitting activities resemble each other strikingly, factors II′ and III′ weighing rather heavily, while factor I′ has a value approaching zero In the case of dressing and circle-standing activities, on the other hand, factor I′ dwarfs the other two The apparatus work, virtually uninfluenced by factor II′ and about equally influenced by the factors I′ and III′, resembles pedal activity indoors more than it does the others.

Summary

A multiple factor analysis of nine different measures of activeness described in an earlier study suggests that three common factors (in the Thurstone sense), in addition, of course, to specific and error factors, will account for most of the variance.

Though the task of labelling the common factors is difficult, the general pattern of our results causes us to advance the hypotheses that the three factors may be strength or maturity, nervousness or emotionality, and spontaneous activeness or aggressiveness

Since the uniqueness of each measure is considerable and the weight patterns of the common factors highly variable from measure to measure, the hazards of predicting a child's relative activeness on the basis of behavior samples such as we used, but limited to one type of situation, must be apparent

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BOOKS

GLADYS C SCHWESINGER *Heredity and Environment. Studies in the Genesis of Psychological Characteristics.* (Ed by Frederick Osborn) New York: Macmillan, 1933 Pp 479

As the author states, this volume represents an attempt to bring together in organized form the main facts relating to the age-old problem regarding the relative importance of heredity and environment in human development The emphasis throughout has been placed upon the mental and behavioral aspects of development, rather than upon physical and physiological factors. Within the field, as thus restricted, the volume may be regarded as a most valuable compendium of information The extensive bibliographies are classified according to topics and afford an invaluable reference source to the busy workers on the several topics covered

The author has been able to take a sound and common-sense viewpoint with respect to the heredity-environment controversy. The point is continually stressed that these two factors always operate together in the process of development. The difficulties involved in any attempt to isolate one or another of the factors of this fundamental complex is duly recognized The conclusions drawn from studies on identical twins in different environments are regarded as indicative and tentative rather than positive and final This sane and wholly commendable attitude doubtless accounts for the emphasis on fact instead of interpretation in the volume and greatly enhances the value of the treatise for both student and general reader.

The scope of the volume can best be indicated by an enumeration of the main topics. The first two chapters deal with the problem of the measurement of intelligence and personality. In the third chapter, the genetic basis of the heredity factor in the developmental pattern is briefly outlined Such facts as are known concerning the relative importance of heredity and environment in development are brought together and critically evaluated in the fourth chapter. This treatment comprises nearly 200 pages and constitutes the most important section of the book Numerous and diverse viewpoints relating to the nature of personality are presented in Chapter 5 In the final chapter on general conclusions, the author is inclined to take a middle ground and reject the views of both the extreme nativists and the extreme environmentalists, on the basis of the evidence now at hand.

The present reviewer feels that no one who is seriously interested in the socio-economic problem raised by the heredity-environment problem should fail to read this volume While the book is written in a scholarly manner, it is not technical in style, and is suitable for both the student and the intelligent layman

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SUBJECT INDEX